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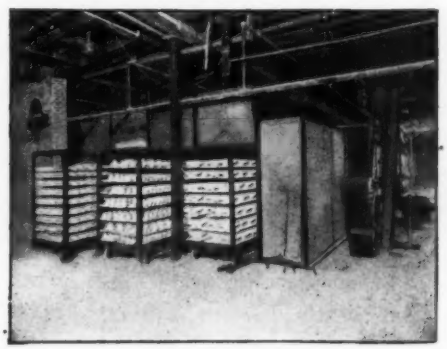

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ORIGINAL PAPERS

THE PRODUCTS OF THE CALCINATION OF FLINT AND CHALCEDONY[1]

BY EDWARD W. WASHBURN AND LOUIS NAVIAS

ABSTRACT

Outline of the Investigation.—This investigation includes the measurement of the following physical properties; specific gravity at 0°, 25° and 98°, the index of refraction, the coefficients of thermal expansion up to 300°, the inversion temperature and volume change on inversion, and the X-ray spectra, the materials studied being quartz, tridymite, cristobalite, silica glass and raw and calcined flint and chalcedony.

New Methods.—For specific gravity, a special vacuum pycnometer was employed and the immersed powder was later subjected to a pressure of 1000 atmospheres.

Results.—The numerical data obtained are summarized in Table I and the X-ray spectra are shown in Fig. 10. The specific gravity of calcined chalcedony was raised 2% by fine grinding.

Conclusions.—All of the known facts concerning chalcedony are in harmony with the theory that the raw material is colloidal quartz and the calcined material colloidal cristobalite.

I. Introduction

1. Purpose of the Investigation.—Silica is known to occur in three distinct enantiotropic forms, each form having two or more enantiotropic sub-forms. These forms are quartz (α and β), tridymite (α, β_1 and β_2) and cristobalite (α and β) to which may be added silica glass, the amorphous or liquid form. The various transition and fusion temperatures

[1] Received June 7, 1922. Presented at the St. Louis Meeting of the Society, March, 1922.

and the ranges of stable existence of all of these forms have been accurately determined by Fenner.[1] The position of the mineral chalcedony in this system has, however, never been satisfactorily established although Fenner seemed inclined to view it as a form different from any of the preceding.

The present investigation was undertaken as a contribution to the elucidation of the chalcedony puzzle and for the purpose of clearing up certain conflicting data and conclusions reported in the literature concerning the properties and nature of the products obtained through the calcination of flint and chalcedony.

Mineralogical Nature of the Materials

2. Chalcedony.—Chalcedony is a natural form of silica, described by the mineralogists as cryptocrystalline, occurring in translucent or opaque botryoidal, reniform, or stalactite masses composed of optically biaxial fibers. It is waxy or greasy in lustre, somewhat splintery in fracture and usually exhibits a banded structure.

3. Flint.—Flint is classed by the mineralogists as a type of chalcedony consisting largely of the siliceous remains of sponges, diatoms, and other marine organisms. It is thus sedimentary in origin and is not as pure as chalcedony proper. It is translucent to gray, brown, or nearly black, the coloring matter frequently being entirely organic in nature so that a black flint may become perfectly white on calcination. The term flint as used by the mineralogists and as employed in this paper is to be carefully distinguished from "potters flint," a commercial term employed in America to designate pulverized quartz.

The Work of Previous Investigators

4. The Work of Le Chatelier.—Beginning in 1889 Le Chatelier made a number of investigations of the different forms of silica and of their behavior on heating to high temperatures. A summary[2] of all of his previous work was published in 1913 and his main conclusions are as follows:

1. On heating, the expansion of chalcedony is similar to that of quartz and it shows a similar anomalous volume increase at 600°.

2. On heating to 1400° in a "porcelain kiln" chalcedony is transformed into cristobalite.

His expansion curves are reproduced herewith (Fig. 1).

The curve marked "cristobalite" in Fig. 1 is, in fact, identical with a curve marked "calcined chalcedony" in a similar diagram published in 1890 and has apparently been taken from the 1890 paper and relabeled.

[1] Fenner, *Amer. Jour. Sci.*, **36**, 380 (1913); cf. Ferguson and Merwin, *Ibid.*, **46**, 417 (1917).

[2] Le Chatelier, "Revue Universelle des Mines," **1**, 85–142 (1913); also, "La Silice et les Silicates," Hermann et Fils, Paris (1914).

With reference to the specific gravity of the calcined chalcedony Le Chatelier states in his 1890 paper that the chalcedony was calcined at 1500° ("four à porcelaine dure") and had a specific gravity of 2.16, while in his 1913 paper he states that chalcedony calcined at 1400° has a specific gravity of 2.3. No explanation of this discrepancy is offered by Le Chatelier.

3. On heating quartz, or better still, chalcedony, to a high temperature, insufficient to produce tridymite, a form of silica, "Silica X," is produced which shows a sudden expansion at 210°.

Le Chatelier then gives his expansion data on this "X" form of silica and these data are identical with those expressed by his curve labeled "cristobalite" in Fig. 1.

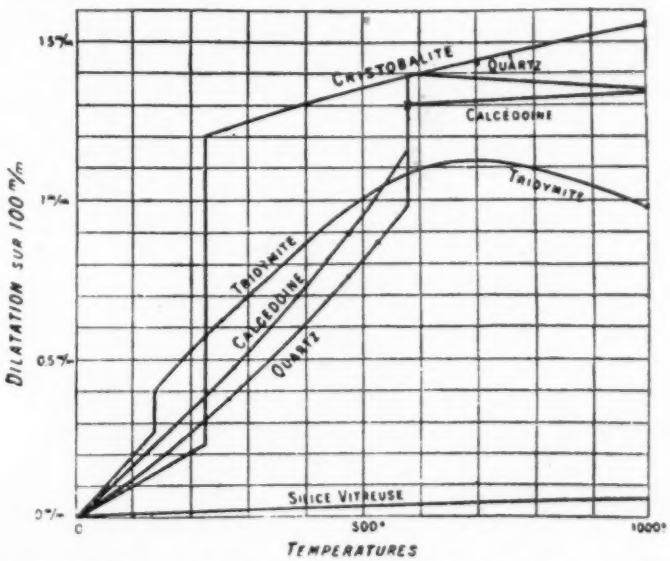


FIG. 1.—The thermal expansions of the various forms of silica. After Le Chatelier.

With regard to the behavior of raw chalcedony, Fenner,[1] who replotted Le Chatelier's results, concluded that they gave no satisfactory evidence of any transformation in the neighborhood of 600° and that is also our own conclusion based upon a study of Le Chatelier's data. Fenner also found by a thermal analysis of raw chalcedony that its cooling curve exhibited no thermal effect at the quartz α-β inversion temperature. In other words none of the above data indicated that raw chalcedony could properly be classified as a form of quartz.

Le Chatelier's determinations of the coefficient of expansion seem to indicate that the chalcedony which he studied transformed into cristo-

[1] Fenner, *op. cit.*, p. 380.

balite on calcination. His statements regarding its specific gravity are, however, conflicting. The value 2.3 is the specific gravity of cristobalite, while the value 2.16 agrees with the results for calcined chalcedony obtained by later investigators and is lower than the specific gravity of any of the recognized forms of silica.

5. The Experiments of Rieke and Endell.—In 1913, Rieke and Endell[1] published an extensive investigation of the properties of various forms of silica after calcination. Their values for the volume changes produced by calcination are reproduced herewith (Fig. 2). They conclude that in the case of flint and chalcedony the product of calcination is cristobalite, a conclusion which is, however, not borne out by their specific gravity data as shown in Fig. 2. Their conclusion was based upon the dilato-

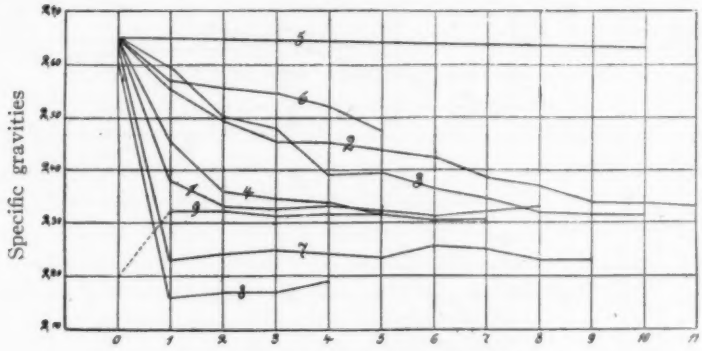


FIG. 2.—Effect of repeated calcinations upon the specific gravity of various forms of silica. After Rieke and Endell.

1. Norwegian quartz, in pieces. 2. Sand from Hohenbocka. 3. Gyserite from the Taunus district, in pieces. 4. Same pulverized. 5. Rock crystal, in pieces. 6. Same pulverized. 7. Flint, in pieces. 8. Chalcedony, in pieces. 9. Silicic acid.

metric behavior of the calcined materials and their results will be referred to below in connection with our own.

6. The Experiments of Mellor and Campbell.—These investigators compared the volume changes which occur in calcining quartz and flint and called attention to the remarkably low specific gravity of the calcined flint. Their results[2] are reproduced in Fig. 3. These investigators likewise offer no explanation for the low specific gravity of the calcined flint.

7. Braesco's Experiments.—During the progress of the present investigation there appeared a paper by Braesco[3] giving some new data on linear expansion. The materials examined were cristobalite and

[1] Rieke and Endell, *Silikat-Zt.*, **1**, 52 (1913).

[2] Mellor and Campbell, *Trans. Eng. Ceram. Soc.*, **15**, 77–116 (1915–16).

[3] Braesco, *Ann. Physique*, **14**, 5 (1920).

tridymite. The powdered materials were formed into rods 5 cm. long by 8 mm. square, held together with 5 per cent of a 36 per cent solution of sodium silicate. These rods were heated in a tube furnace together with a rod of silica glass which was used as a standard of comparison. A mirror attached to the ends of the two rods was tilted by the unequal expansions and the movement of the beam of light was registered photographically.

His data on tridymite, which show both the α-β_1 and the β_1-β_2 inversion expansions, are reproduced graphically in Fig. 4 together with those of Le Chatelier. The small circles represent Le Chatelier's original data. The dot-dash curve represents the one drawn by Le Chatelier to express

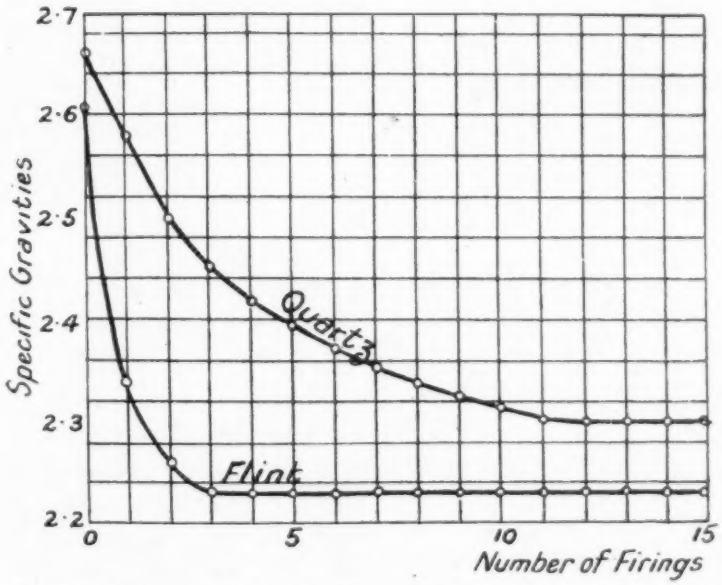


FIG. 3.—Effect of repeated calcinations upon the specific gravity of flint and quartz. After Mellor and Campbell.

these results. In his paper of 1913, however, he gives a curve whose locus is the solid curve of our Fig. 4, but does not indicate that any new experimental data were obtained. The small crosses and the dash-curve through them represent Braesco's data. The right hand set of curves represents the lower portion of the other set on a magnified scale.

Braesco's data on cristobalite will be discussed below in connection with our own.

Preparation of the Materials

8. The Flint.—The flint employed in our experiments was prepared from selected black European pebbles supplied for use in ball mills. The

pebbles were first calcined at 1140°C and from the fragments thus obtained, pure white specimens were selected, crushed in a steel mortar, and finally pulverized in an agate mortar to pass 150 mesh. The powder was then washed with hot hydrochloric acid to remove iron and lime and after removing the acid with hot water, the powder was dried.

The purified powder thus obtained was calcined for two hours at 1430–1460°C in a gas-fired furnace, the total time of heating being four hours. The product of this calcination, after another washing with hydrochloric acid, was analyzed and found to contain 99.60 per cent SiO_2. Rieke and

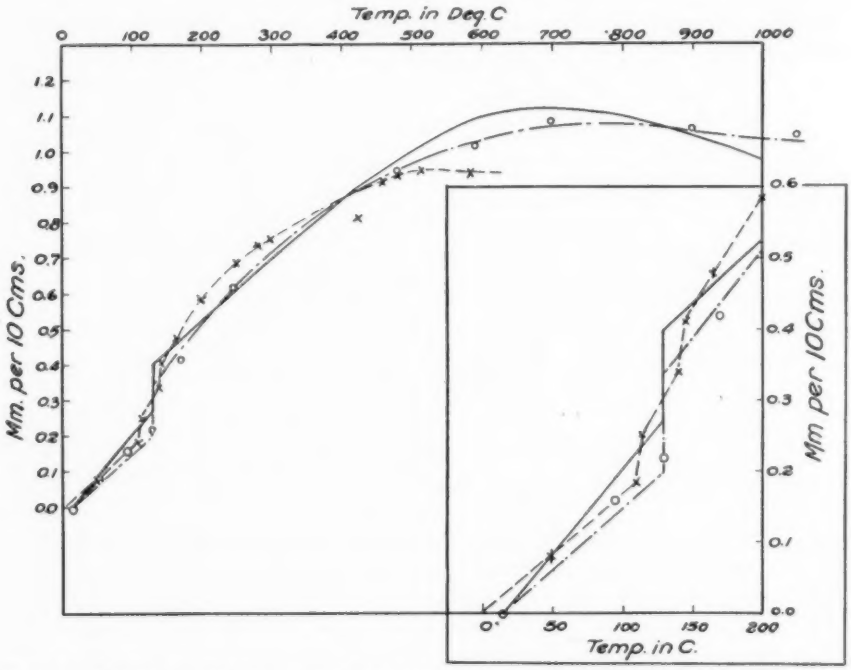


FIG. 4.—The thermal expansion of tridymite. After (1) Le Chatelier and (2) Braesco.

Endell's flint analyzed 98.7 per cent SiO_2, while that of Mellor and Campbell had 98.2 per cent SiO_2 in the raw state, but only 93.6 per cent after calcining and grinding, the impurities introduced being CaO, Al_2O_3 (4.6%) and alkalies (0.5%).

9. The Chalcedony.—The chalcedony was a very pure specimen obtained from the collection in the United States National Museum, its original source being the Yellowstone National Park. A thin section of the material showed the finely fibrous development characteristic of chalcedony, the white banded portions being composed of larger fibers than the gray, translucent interior. Selected portions of the wax-like interior

were broken up and put through the same treatment as that employed with the flint. The final product was pure white and analyzed 99.87 per cent SiO_2. The chalcedony studied by Rieke and Endell contained 99.8–99.9 per cent SiO_2 after calcination.

10. The Tridymite.—The tridymite was prepared by calcining a mixture of 4 parts of the calcined flint with 1 part of sodium tungstate for 150 hours at 1300°C. The calcined mixture was then washed with hot water, followed by hydrochloric acid and ammonia as described by Fenner.[1] Microscopic examination showed the plate structure, the twinning, and the parallel extinction characteristic of tridymite. The index of refraction was 1.4750.

11. The Cristobalite.—The cristobalite was prepared in the same way as the tridymite, but with a 7-hour calcination at 1500°. Microscopic examination showed the characteristic skeleton-like forms described by Fenner. The index of refraction was higher than 1.4830.

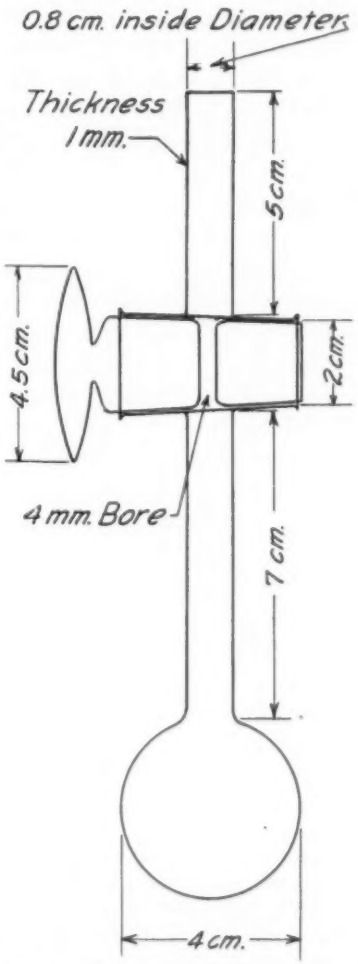


FIG. 5.—Pycnometer of pyrex glass.

The Specific Gravity Determinations

12. The Weighing Procedure.—The pycnometer shown in Fig. 5 was employed. Previously to placing it upon the balance pan the outside was wiped with a damp cloth. A glass counterpoise having the same superficial area was treated in the same way, and placed upon the opposite pan of the balance in all weighings, thus eliminating any errors due to variations in superficial moisture and ensuring a rapid attainment of equilibrium in the balance case. Readings of temperature, barometricpres sure, and humidity of the balance case were made in connection with every weighing and all weights were reduced to *vacuo*.

13. Determination of the Weight of the Dry Powder.—The bulb of the pycnometer was filled with the powder with the aid of a funnel

[1] Fenner, *Trans. Soc. Glass Tech.*, **3**, 120 (1919).

whose stem passed through the stop-cock to the bottom of the bulb. The pycnometer was then placed in position in the small electric furnace, *a*, and connected to the evacuating system as shown in Fig. 6. The furnace was slowly ($1^1/_2$ hours) brought up to 400°, kept there for one hour and then cooled (1 hour) to room temperature. Throughout this operation the vacuum pumps maintained a vacuum of better than 0.02 mm. in the pycnometer.

By means of a drying train connected to *g*, air, dried by calcium chloride and phosphorus pentoxide, was then admitted to the pycnometer, after which its stop-cock was closed and it was disconnected and transferred to the balance case for the first weighing. The above operation was then repeated and the weighing checked.

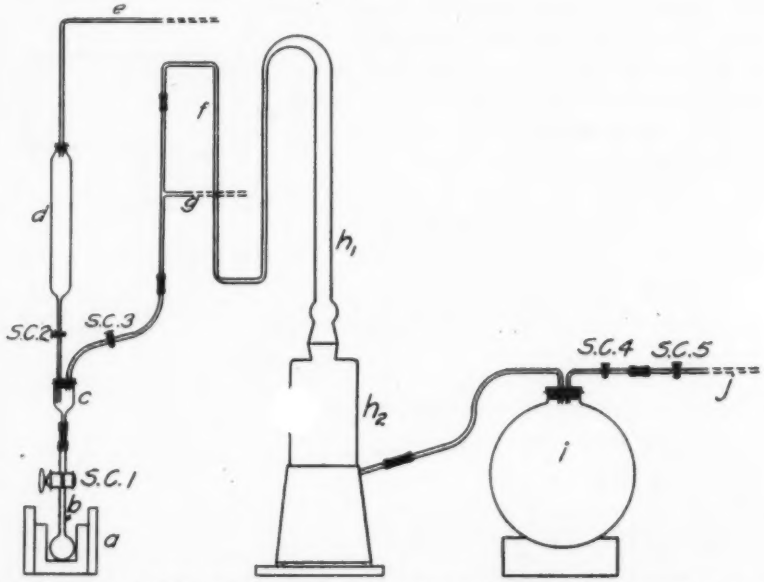


FIG. 6.—Illustrating the apparatus for evacuating and filling the pycnometer. *a*, electric furnace; *b*, the pycnometer; *d*, separatory funnel; *e*, connection to supporting pump; *g*, connection leading to McLeod gauge and to drying train; h_2, Langmuir mercury vapor pump; *i*, receiving flask; *j*, connection to supporting pump.

14. Adsorption of Air by the Powder.—In one experiment the pycnometer was removed without admitting air and weighed while evacuated in order to ascertain if there was any appreciable adsorption of dry air by the powder. The results showed that the adsorbed air could not have amounted to more than 0.01% of the weight of the powder.

15. Filling the Pycnometer with Water.—The pycnometer containing the dry powder was connected to the stem of a separatory funnel containing distilled water (*d*, Fig. 6). After evacuating the pycnometer and the

stem of the separatory funnel (0.02 mm.), the water in the funnel was boiled *in vacuo* for 15 minutes and then admitted to the pycnometer by opening S. C. 2. When full, the pycnometer was removed to a constant temperature bath and allowed to come to equilibrium. The stop-cock was then closed and after removing the excess water above it and drying the outside, the pycnometer was transferred to the balance case and weighed. In the case of the determination at 0° the pycnometer, after removal from the ice bath, was first placed in a bath at room temperature and its stop-cock opened for a short time in order to permit the water to expand before weighing.

The thermometers used were compared with a standard certified by the National Bureau of Standards and all necessary corrections were applied. All temperatures in this paper are in degrees Centigrade.

16. Determination of the Volume of the Pycnometer.—This determination was carried out by the procedure just described. The determination was made both before and after the pycnometer had been subjected to the heat treatment described in Sec. 13 the results being 36.985 cc. and 37.005 cc. respectively. The latter value was used in the calculations.

17. The Results.—The following specific gravity values were obtained.

Calcined flint: $D^{25°}/_{25°} = 2.251$, $D^{25°}/_{4°} = 2.245$.

This result is lower than the values 2.27 and 2.33 which Fenner[1] found for tridymite and for cristobalite, respectively at $^{27°}/_{27°}$. Mellor and Campbell's values for calcined quartz and calcined flint are slightly lower than ours, the former being 2.32 and the latter 2.22, but they employed only the customary method of specific gravity determination, and the small difference might well have been due to the failure of their method to completely fill all fine cracks with the immersion liquid. It is evident that nothing but sealed pores or micro-pores could escape being filled by the method employed in our measurements. Mellor and Campbell's flint also contained considerable quantities of fluxing materials which might have influenced the result somewhat.

Calcined chalcedony: $D^{25°}/_{25°}=2.175$, $D^{25°}/_{4°} = 2.169$, $D^{0°}/_{4°} = 2.174$, $D^{95°}/_{4°}=2.172$. The result for room temperature is lower than any of the values (2.194 to 2.213) given for silica glass. Rieke and Endell found values even lower, ranging from 2.16 to 2.19 and Le Chatelier obtained the value 2.16 for his chalcedony calcined at 1500°. The values given in the literature for the specific gravity of silica glass vary from the value 2.194 found by Schwarz[2] to the value 2.213 found by Day and Shepherd,[3] the value ordinarily given being 2.20.

From our results at 0° and 95° it is evident that the expansion of cal-

[1] Fenner, *op. cit.*, p. 352.

[2] Schwarz, *Z. anorg. Chem.*, **76**, 423 (1912).

[3] Day and Shepherd, *Amer. Jour. Sci.*, **22**, 276 (1906).

cined chalcedony over this temperature range is not appreciable. Thus in this respect also it resembles silica glass.

18. Effect of High Pressures upon the Specific Gravity Results.—With the thought that the presence of micro-pores or cracks might possibly be the explanation of the apparent low specific gravity exhibited by the calcined chalcedony, it was deemed desirable to subject the immersed powder to high pressures to see if any additional water could be forced into it.

Eight grams of the powder were therefore removed from the pycnometer, transferred to a glass vial and the whole weighed while immersed in water. The vial containing the powder under water was then sent to the Geophysical Laboratory at Washington where it was placed in the high pressure machine and subjected, while immersed in water, to a pressure of 1000 atmospheres for two hours. After this treatment its weight in water was again taken and was found to have increased slightly, the increase being equivalent to a specific gravity increase of only six units in the fourth decimal place. The value 2.175_6 ($^{25°}/_{25°}$) must therefore be taken as the specific gravity of the material, which seems thus to be, without question, specifically lighter than ordinary silica glass.

19. The Effect of Fine Grinding.—The low value of the specific gravity of calcined chalcedony might obviously be due in part to the presence of numerous small *sealed* pores of microscopic or sub-microscopic dimensions. In order therefore, to test this hypothesis, a sample of the material was ground in an agate mortar and the finest particles were separated by stirring up the material with water and allowing it to settle for 48 hours. The milky supernatant liquid was then removed and evaporated to dryness at low temperature. When sufficient material had been obtained in this way, the average size of the particles was determined with a micrometer microscope and they were found to be 0.0023 mm. in diameter. The density of this material was then measured and found to be 2.224, an increase of 2 per cent over the previous value, thus showing definitely the presence of an appreciable volume of extremely small pore spaces.

This result is, we believe, the first instance of an appreciable effect of fine grinding upon the density of a mineral. The careful experiments of Johnston and Adams[1] upon the density of quartz powder of different degrees of fineness, down to particles smaller than 0.02 mm. led them to the conclusion that "When homogeneous material, free from cracks and holes, is powdered, the change of density thereby produced is but little greater than the error of the method employed. It may be noted, however, that the change, if real, is....a *decrease;*...." It is evident that the behavior of calcined chalcedony constitutes an exception to this conclusion unless submicroscopic pores are to be included in the term "holes."

[1] Johnston and Adams, *Jour. Amer. Chem. Soc.*, **34**, 572 (1912).

The Dilatometer Experiments

20. The Apparatus.—The dilatometer employed consisted of a bulb of pyrex glass 4 cm. in diameter and 10 cm. high with a capillary tube 100 cm. long and 1.93 mm. bore, ground into its neck. About 50–60 grams of the powder were placed in the bulb and the remaining space filled with a mixture of 95-per cent sulphuric acid with potassium sulphate, the specific gravity of the mixture at $^{25°}/_{25°}$ being 1.94. The capillary tube was then cemented into its socket and all enclosed air carefully eliminated. The heating arrangement is shown in Fig. 7.

21. The Heating and Cooling Curves.—The results of some of the dilatometric experiments are displayed in Fig. 8. These results will be discussed under the headings of the materials studied.

(*a*) *Tridymite.*—The cooling curves obtained with pure tridymite were smooth and almost straight throughout the complete range from 95° to 250°. The purity of the material was evidenced by the absence of any volume change in the α-β cristobalite inversion range. The simple method of heating or cooling curves proved to be not sensitive enough to show directly the small volume change which occurs at the α-β_1 tridymite inversion temperature. In order, therefore, to measure this volume change, the following procedure was adopted:

The dilatometer was filled with the sulphuric acid mixture (144.1 grams) and a slow cooling curve was taken over the tridymite inversion range. This curve was a perfectly straight line. From the known diameter of the capillary (1.93 mm.) and the weight of the mixture, the average volume change per gram per degree was calculated to be 26.0×10^{-5} cc. for the acid mixture, in glass.

The dilatometer was then filled with known weights of tridymite and of the acid mixture and readings taken when equilibrium was reached at 106.8° and 124.8°, respectively. Using the above factor for the expansion of the acid mixture, the expansion of the tridymite over this temperature range was calculated to be 93×10^{-5} cc. per gram. Then from the cooling curve of tridymite, its expansion was calculated to be $(3.8\pm0.8)\times10^{-5}$ cc. per gram per deg., or (0.008 ± 0.002) per cent per deg., above its transition temperature and $(1.5\pm1.2)\times10^{-5}$ cc. per gram per deg., or (0.003 ± 0.002) per cent per deg., below its transition temperature, 117°. From these values the purely thermal expansion between 106.8° and 124.8° was calculated to be $(30\pm6)\times10^{-5}$ cc. per gram, whence by subtraction we find the volume increase for the inversion $\alpha\longrightarrow\beta_1$, to be $(63\pm6)\times10^{-5}$ cc. per gram or (0.14 ± 0.01) per cent.

From Braesco's data[1] on the linear expansion of tridymite rods held together with sodium silicate we may also compute the coefficients of

[1] Braesco, *op. cit.*

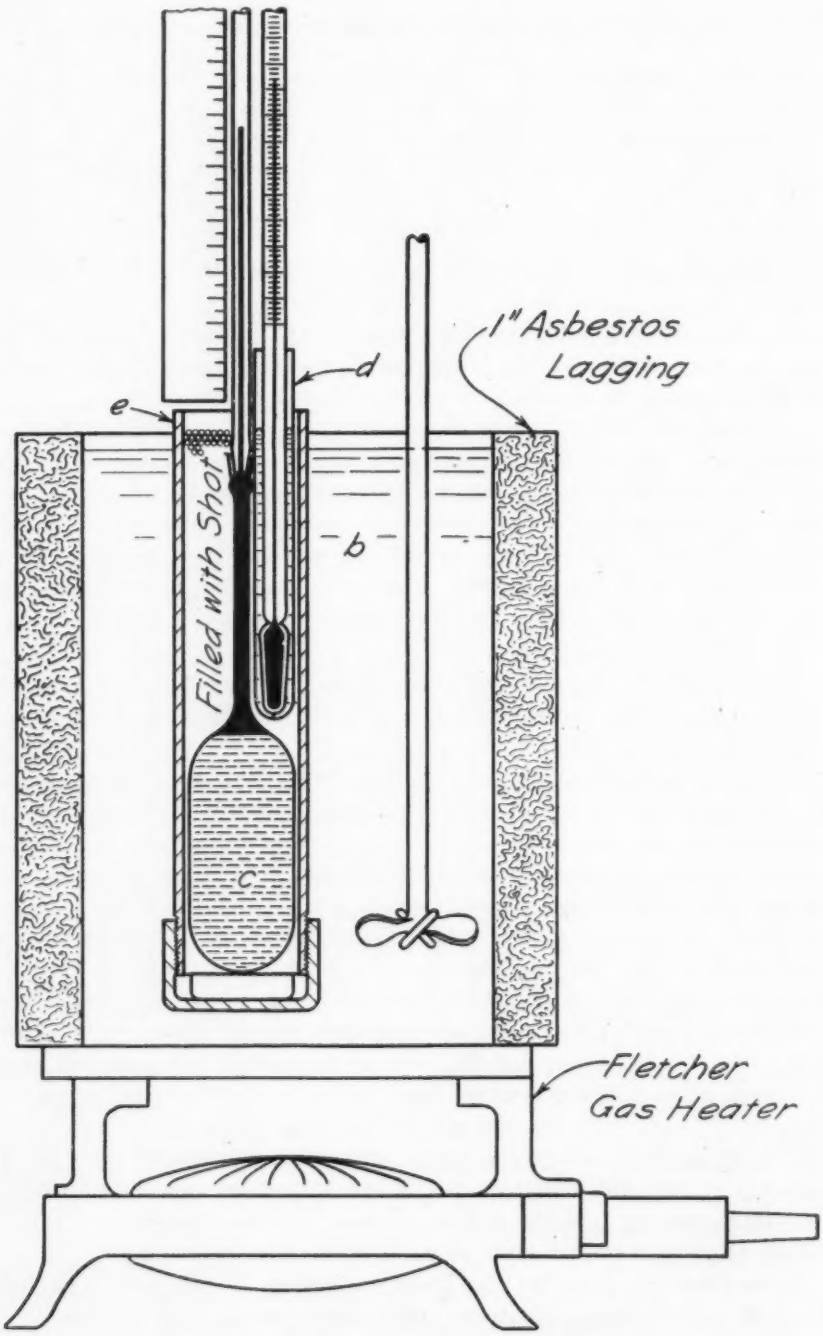


FIG. 7.—Dilatometer and heating arrangement.

cubical expansion and the volume increase on inversion. The values so computed together with our own are shown in Table I. The agreement is as good as could be expected.

(*b*) *Cristobalite.*—The cooling curves for cristobalite and for the acid mixture alone, over the same range, are shown in Fig. 8. From these curves the total expansion of the cristobalite between 198° and 251° was found to be 0.0198 cc. This expansion is made up of the ordinary thermal dilation plus the volume increase which accompanies the inversion. From the data obtained the coefficient of expansion of the β cristobalite between 235° and 251° was computed to be $(1.5 \pm 0.4) \times 10^{-4}$ cc. per gram per degree, or (0.032 ± 0.008) per cent per degree and that of α cristobalite between 198° and 205° $(1.1 \pm 0.5)\ 10^{-4}$ cc. per gram per degree, or (0.024 ± 0.011) per cent per degree.

If we call the point of inflexion, (229°), in the time-height curve, the "inversion temperature," then from the data obtained, the inversion expansion for this temperature is found to be 132×10^{-4} cc. per gram, or about 2.83 per cent.

Similarly from Braesco's data we may compute the coefficients of cubical expansion and the volume increase on inversion. These results together with our own are shown in Table I. With the exception of the value for β cristobalite, these results agree with ours within our experimental errors.

(*c*) *Quartz.*—Pulverized quartz sand was employed. The results are shown in Fig. 8.

(*d*) *Silica Glass.*—Fig. 8 shows the cooling curve obtained with 60 grams of powdered transparent silica glass and 91.7 grams of the acid mixture. From the curve for the acid mixture alone two points representing the expansion of 91.7 grams of the acid mixture between 186° and 225° were computed and marked on the curve for silica glass. It will be seen that these two points fall practically upon the cooling curve for silica glass which should, of course, be the case, if the expansion of the silica glass is negligible.

(*e*) *Calcined Flint and Calcined Chalcedony.*—The cooling curves of both materials were perfectly linear up to 180°. Between this temperature and 215° a marked increase in volume takes place, with both materials. The cooling curves are shown in Fig. 8 and the expansion data in Table I.

Since Fenner has shown that the inversion temperature of cristobalite depends upon the source and previous heat treatment of the sample under investigation, it is evident that we must conclude that calcined flint and chalcedony both exhibit the cristobalite inversion. This agrees with the conclusion reached by Rieke and Endell based upon dilatometric experiments in which a dilatometer with a 5 cc. bulb was employed. They found a break at 228° in the cooling curve of their calcined flint which agrees well with our value, 227°. Further details are not given.

The Inversion Temperatures

22. Thermal Analyses of the Materials.—Qualitative thermal analyses were made on the materials to determine the temperature at which the inversions take place. A suitable test tube, filled with the material in which the bulb of a thermometer was imbedded, was placed in the iron cylinder of the dilatometric set-up and well insulated. Cooling curves were then taken. The results follow.

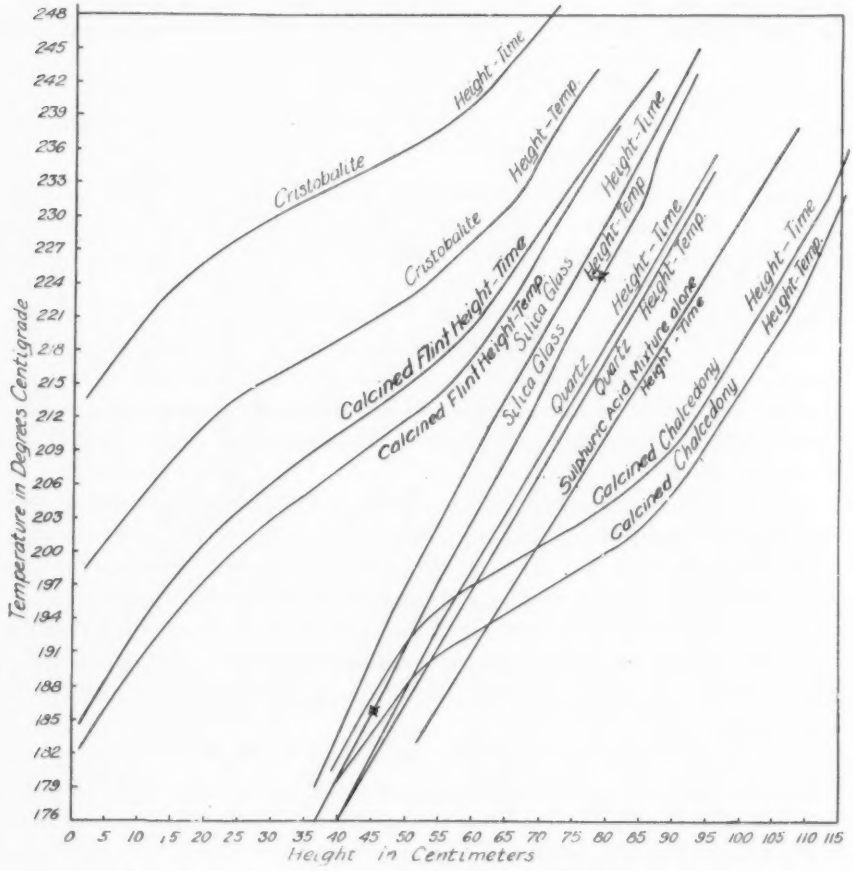


FIG. 8.—Cooling curves.

(*a*) *Tridymite.*—The range, 105°–138°, yielded only a smooth curve, showing that the heat of reaction at the inversion was exceedingly small.

(*b*) *Cristobalite.*—The inversion started at 244°. The change of slope is very evident, see Fig. 9.

(*c*) *Calcined flint.*—Fig. 9 shows an inversion starting at 227°.

(*d*) *Calcined chalcedony.*—An inversion starting at 220° is shown in Fig. 9.

Indices of Refraction

23. Method.—The indices of refraction of the powdered materials were measured with the petrographic microscope, using the Becke line method. The distinction between tridymite and cristobalite was made by means of a liquid of index, 1.4784.

24. Results.—The results are shown in Table I. In each instance *all* of the material fell within the index limits given.

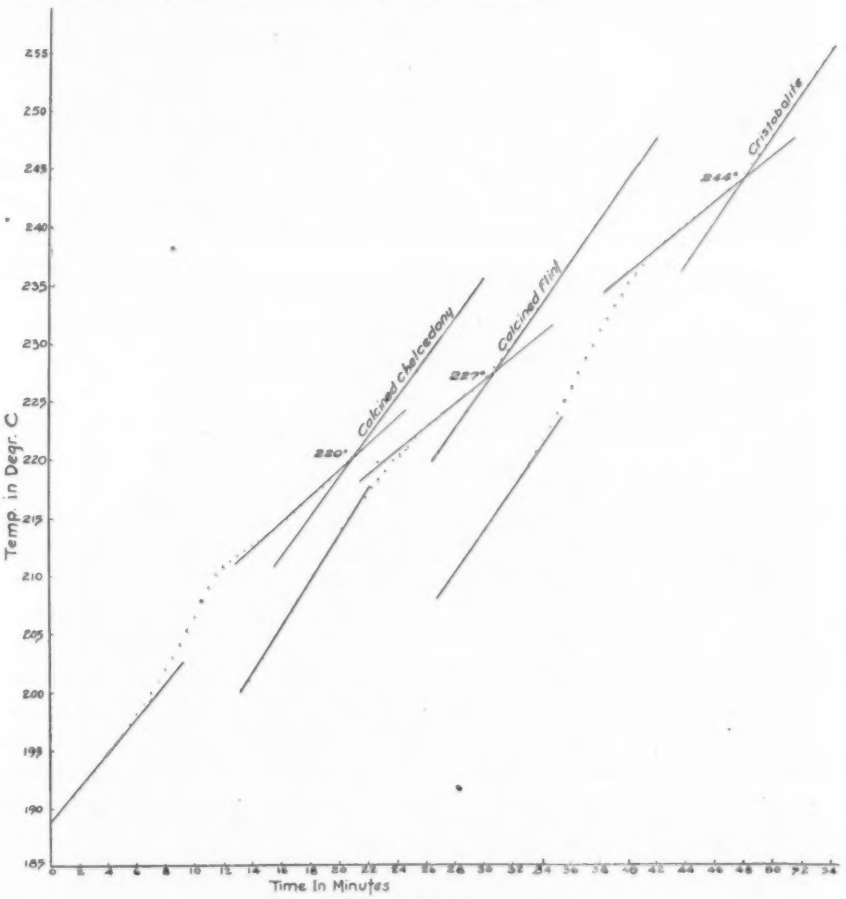


FIG. 9.—Thermal analysis curves.

Rieke and Endell's microscopic examination[1] of their materials did not include a determination of the refractive index. They state merely that thin sections of their calcined materials when examined with crossed Nicols appeared to be *completely isotropic*, but that under the highest magnification certain spots seemed to be anisotropic.

[1] Rieke and Endell, *op. cit.*, p. 69.

25. Some Miscellaneous Experiments.—A small quantity each of the raw flint and the raw chalcedony was dropped into a platinum crucible and heated before a blast lamp for one minute and the index of refraction then measured. The raw flint after this treatment gave 1.500–1.519 and the chalcedony 1.500–1.526. Just what these values signify is not clear.

In a second experiment some of the raw flint was maintained at a temperature of 830° for 700 hours, one sample being drawn at the end of 1½ hours and another sample at the end of each 24 hour period. All of the samples drawn gave the same index of refraction, namely, 1.500–1.519 which is also the value obtained in the one minute experiments just described.

A sample of chert (?) obtained from deposits in the neighborhood of Tamms in the southern part of the State of Illinois was calcined at 1450°C for a few hours and its index measured. The following results were obtained: Raw "Joynt's" Silica, 1.542–1.550; calcined material, 1.478–1.493. The raw material thus has the index of quartz and the calcined material that of cristobalite.

The Significance of the Results

26. Comparative Summary.—In Table I the results obtained for raw and calcined flint and chalcedony are summarized and compared with the corresponding data for silica glass, cristobalite, tridymite and quartz.

A study of the data given in the table brings out the following facts: (1) The density of raw flint and chalcedony is appreciably lower than, but close to, that of quartz, the difference being not greater than that which might possibly arise from the presence of moisture and other impurities in the raw material. The density of the calcined flint is slightly lower than, but close to that of tridymite. The density of the calcined chalcedony is distinctly lower than that of silica glass, the lightest known form of silica.

(2) The indices of refraction of the raw flint and chalcedony are substantially the same and while close to that of quartz are distinctly lower. The index of the calcined flint is close to that of cristobalite, while the index of the calcined chalcedony is definitely lower than those of cristobalite and tridymite but agrees very well with that of silica glass. As far as these two properties are concerned, therefore, the calcined chalcedony might be considered as a form of silica glass, while the calcined flint might be either cristobalite or tridymite.

(3) Both the calcined flint and the calcined chalcedony exhibit a typical α-β cristobalite inversion.

The net result of the investigation thus far seemed to be that calcined chalcedony was either a new form of cristobalite with a density and index of refraction different from ordinary cristobalite or else that it was a form

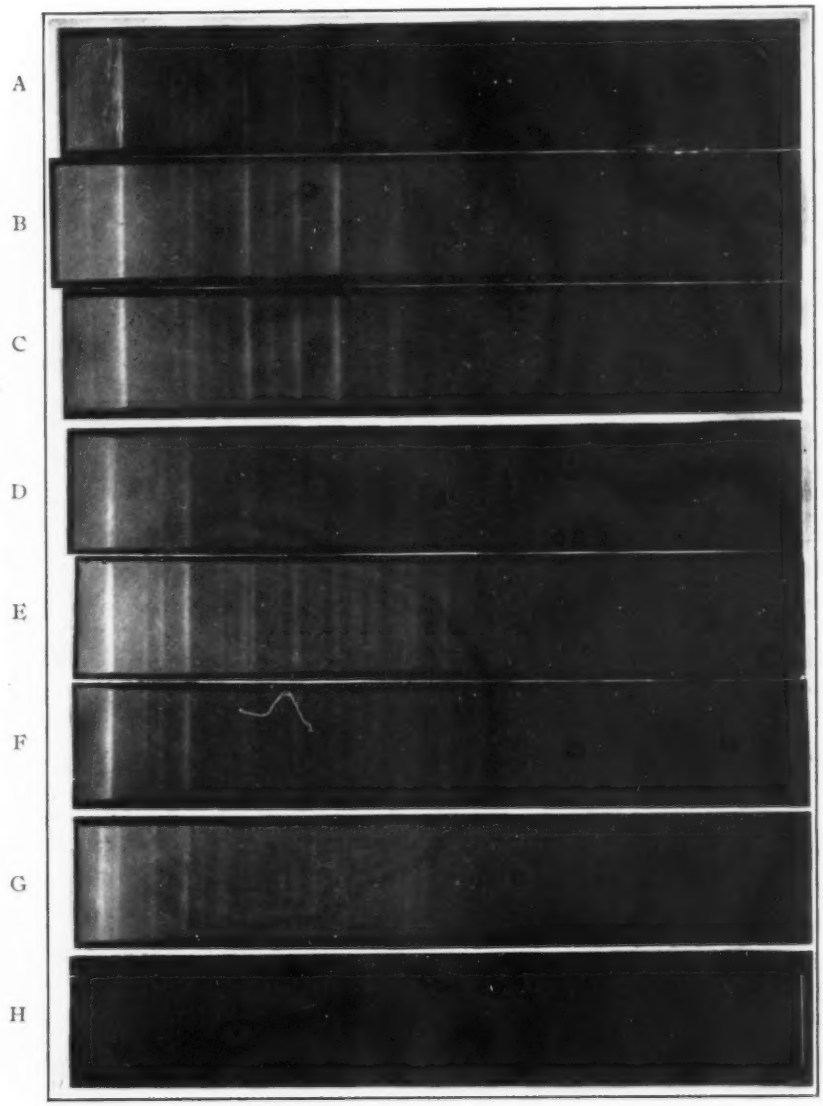


FIG. 10*a*.—X-ray crystal spectra.

A, quartz crystal; B, raw flint; C, raw chalcedony; D, cristobalite; E, calcined flint; F, calcined chalcedony; G, tridymite; H, silica glass.

of amorphous silica (silica "glass") which exhibited enantiotropism. In order, therefore, to determine (1) whether the material was crystalline or amorphous and (2) if crystalline, the species of crystal present, recourse was had to the method of X-ray crystal analysis described in the next section.

X-Ray Spectra

27. The Method of X-Ray Crystal Analysis.—When a narrow beam of monochromatic X-ray is passed through a powdered crystalline material the rays are diffracted by the layers of molecules on the various crystal surfaces, and if the diffracted rays are received upon a photograph plate, a spectrum of lines and bands of various intensities is obtained. The number, positions, and intensities of these lines are characteristic for each species of crystal. This method, originated by Laue and modified and improved by Bragg and Bragg,[1] Hull,[2] Debye and Scherrer, and Clark and Duane,[3] is, especially in the form devised by Hull, a new and valuable research tool which should find important application in ceramic investigation.

28. Results.—Through the coöperation of the General Electric Company we were enabled to secure the X-ray spectra of all of our materials. These spectra were photographed for us by Dr. A. W. Hull and are reproduced in our Fig. 10.

An examination of these spectra shows beyond question (1) that raw flint and raw chalcedony are made up of, or contain in considerable quantity, quartz crystals and (2) that calcined flint and calcined chalcedony are made up of, or contain in considerable quantity, cristobalite crystals and no other crystals of any kind.

Conclusions

29. The Nature of Flint and Chalcedony.—Based upon the results obtained in this investigation, the following theory concerning the nature of flint and chalcedony and their calcination products is proposed. This theory successfully correlates all the known facts concerning these materials.

(1) Flint and chalcedony consist of colloidal quartz. In the purer forms of chalcedony the colloid is of the gel type and the individual colloidal particles are microscopic or sub-microscopic in size.

Fenner[4] found that when chalcedony was heated in contact with a flux at 800°, "quartz" and tridymite were produced. The "quartz,"

[1] Bragg and Bragg, "X-Rays and Crystal Structure." Bell and Sons, London, 1915.

[2] Hull, *Jour. Amer. Chem. Soc.*, **41**, 1168 (1919).

[3] Clark and Duane, *Proc. Natl. Acad. Sci.*, **8**, 90 (1922).

[4] Fenner, *loc. cit.* See footnote No. 1.

i. e., macrocrystalline quartz is evidently the result of the solution and recrystallization of the colloidal crystals, and quartz is of course, the stable form at this temperature. The simultaneous appearance of the metastable tridymite under such conditions is a common phenomenon. On long continued heating the tridymite should, of course, disappear.

Doelter[1] also records the simultaneous formation of quartz during

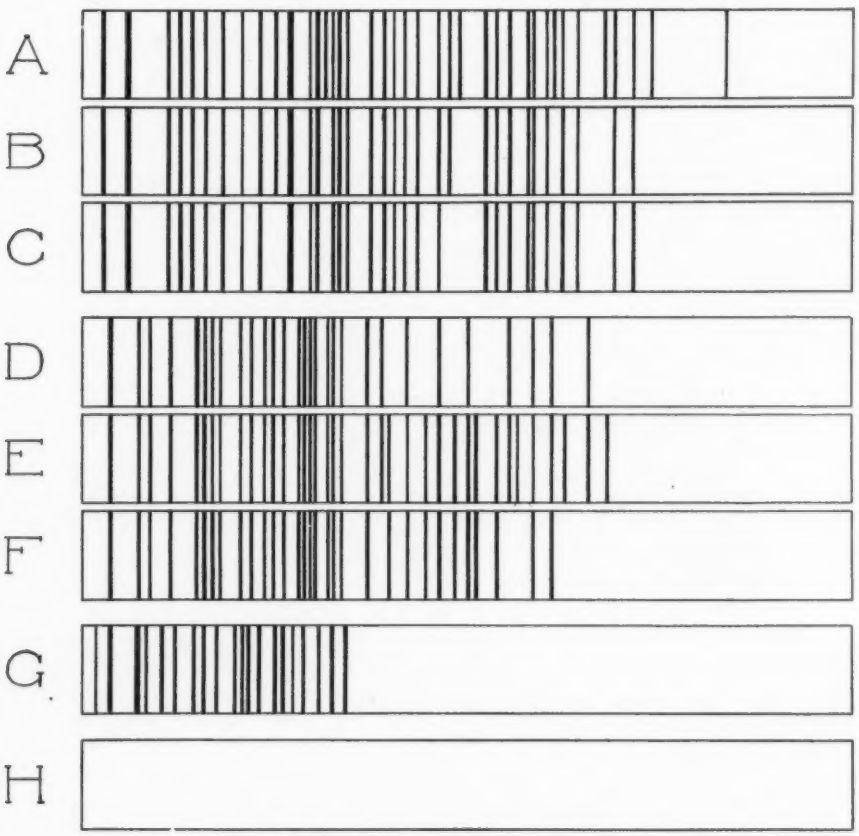


FIG. 10*b*.—X-ray crystal spectra.

A, quartz crystal; B, raw flint; C, raw chalcedony, D, cristobalite; E, calcined flint; F, calcined chalcedony; G, tridymite; H, silica glass.

the synthetic production of chalcedony at low temperatures, and its occurrence in nature closely associated with chalcedony is well known.

(2) When calcined, the colloidal quartz crystals are, owing to the enormous surface which they expose, very rapidly transformed into cristobalite crystals. This is also the behavior of ordinary quartz, but with

[1] Doelter, "Handbuch der Mineralchemie," **2,** II, 175.

this material the rate of conversion is much slower. In the case of the flint, the impurities present act as a flux and thus permit the formation of larger crystals of cristobalite than in the case of the purer chalcedony. The properties of the calcined flint, therefore, approach more closely those of ordinary cristobalite than is the case with the calcined chalcedony. The latter material is so pure that the colloidal quartz particles are transformed in *situ* into colloidal cristobalite particles. The comparatively large volume increase which accompanies this transformation produces small cracks and fissures between the colloidal particles and the simultaneous expulsion of volatile impurities, such as water, perhaps leaves numerous micropores throughout the mass.

At the same time some of the original colloidal quartz crystals, that is, the smaller ones, probably melt since the melting points of many of them must be considerably lower than that ($<1470°$) of ordinary quartz. This "melting" is not, however, accompanied by any appreciable fluidity since silica glass at this temperature is still a fairly rigid solid. The silica glass thus produced would, of course, immediately proceed to crystallize slowly, with the formation of colloidal cristobalite crystals. Lord Rayleigh[1] found that ordinary silica glass exhibits between crossed Nichols a quasi crystalline structure. These crystals, or incipient crystals, probably represent the first stages of the orientation of the silica molecules into the cristobalite groupings and silica glass held for some time at 1400–1500°C and then finely powdered should be substantially the same material as finely powdered calcined chalcedony. Both materials would consist principally of colloidal cristobalite together with a small amount of amorphous silica or silica glass, the relative proportions of the two depending upon the conditions of calcination.

(3) Since there must be a gradual gradation of properties extending all the way from those of isotropic silica glass on the one hand up to macrocrystalline cristobalite on the other, depending upon the degree of dispersion, it is clear that the low index of refraction and low density of the calcined chalcedony are readily understandable on the theory here proposed. A crystal composed of a comparatively small number of molecules, especially if not well formed, must be more or less distorted by forces of the nature of surface tension and corresponding changes in its refractive index are to be expected. Moreover, the exact significance of the refractive index (as measured by the immersion method) in the case of a material containing a considerable quantity of crystals too small to be resolved by the microscope is somewhat uncertain. The results of this method applied to the calcined chalcedony gave index values for different portions of the field ranging from that of silica glass, 1.456, up to 1.470. There were apparently no macrocrystals of cristobalite present. With the cal-

[1] Lord Rayleigh, *Nature*, **104**, 153 (1919).

TABLE I

SUMMARY OF RESULTS

Results in black face type were obtained in this investigation. After calcination at 1450° for 2 hours the chalcedony analyzed 99.87 and the flint 99.6% SiO_2. Inversion temperatures were obtained from cooling curves and volume changes with a dilatometer

	Raw chalcedony	Raw flint	Quartz		Calcined chalcedony		Calcined flint		Cristobalite		Tridymite		Silica glass
			α		α	β	α	β	α	β	α	β_1	
Specific gravity, 25°/25°	2.55–2.61	2.61–2.63	2.65	...	2.175	...	2.25	...	2.33	...	2.27	....	2.194–2.213
Index of refraction	1.533–1.538	1.533–1.539	1.544–1.553	...	1.456–1.470	...	1.483	...	1.484	...	1.475	....	1.457–1.460
Inversion temperature, t_1			575°	570°	...	220°	...	227°	...	244°	117°	....	None
Coefficient of cubical expansion near t_1													
(*a*) Cc. per gram per deg. × 10^4	...	...	0.25	−0.049	1.3± 0.3	1.4± 0.2	0.9± 0.4	1.4± 0.3	1.1± 0.5	1.5± 0.4	0.15± 0.12	0.38± 0.08	...
(*b*) Per cent per degree × 10^2	...	...	0.65	−0.12	2.7± 0.6	2.8± 0.4	1.9± 0.8	3.0± 0.6	2.4± 1.1	3.2± 0.8	0.3± 0.2	0.8± 0.2	...
(*c*) Ditto, from Braesco's data	...	...	...	...	...	...	...	...	1.6	0.65	0.53	1.0	...
Volume increase on inversion $\alpha \rightarrow \beta$ at t_1													
(*a*) Per cent	...	...	2.16		2.63		3.09		2.83		0.142		...
(*b*) Ditto, from Braesco's data	...	...	...		...		...		2.4		0.2		...
(*c*) Cc. per gram × 10^4	...	...	84		131		150		132		6.3±0.6		...

cined flint on the other hand practically all of the material was in the form of macrocrystalline cristobalite.

(4) Fenner made a thermal analysis of raw chalcedony over the quartz α-β inversion temperature and failed to find any heat effect indicating an inversion at this temperature. It was largely because of this negative result that he concluded that chalcedony could not be classified as quartz. Now it is altogether probable that both the inversion temperature and the heat of inversion of a quartz crystal vary markedly with the size of the crystal, for crystals of colloidal dimensions. Consequently, according to our theory of the nature of raw chalcedony, we might expect that the quartz inversion would be spread over a considerable range of temperature owing to the varying sizes of particles present and this inversion might, therefore, easily fail to be detected by the method of thermal analysis. It ought, however, to manifest itself in a dilatometer owing to the large volume change which accompanies the inversion.

30. Acknowledgments.—Through the good offices of Professor T. T. Quirke of the Department of Geology, we were able to secure an excellent sample of chalcedony. This sample was supplied by Dr. G. P. Merrill of the United States National Museum and proved to be an extremely pure material.

To the Geophysical Laboratory of the Carnegie Institution of Washington and especially to Dr. H. L. Adams of that laboratory we are indebted for the high pressure test which was applied to a sample of our material during the course of the work.

To Dr. A. W. Hull of the Research Laboratory of the General Electric Company we are especially indebted for the photographs of the X-ray spectra of the materials. Without these spectra it would have been impossible to bring the investigation to a satisfactory conclusion, since the usual methods of measurement failed to yield a definite solution of the problem.

The experimental data contained in this paper were obtained by the junior author in connection with the preparation of a thesis submitted by him to the Graduate School of the University of Illinois in partial fulfilment of the requirements for the degree of Master of Science in Ceramic Chemistry, in June 1921.

DEPARTMENT OF CERAMIC ENGINEERING
UNIVERSITY OF ILLINOIS
URBANA, ILL

AN IMPROVED MAGNET BOX[1]

By H. Spurrier

ABSTRACT

The plates are made of wrought iron carrying vertical projections, thereby carrying the magnetic poles clear up into the flowing slip.

The slip is broken up into several streams which, on passing the narrow spaces between the fingers, more readily yield their metallic iron.

Settlings in the box do not impair the magnetic efficiency.

During a siege of iron spots in white ware, several lines were investigated as likely contributory causes of our trouble, but still iron spots were discouragingly frequent.

Among other things which were done, one in particular seems worthy of wider application as time has now proven its real utility.

An effort was made to increase the efficiency of the magnet box. The box in question was equipped with malleable cast iron plates, provided with projections of about $^{5}/_{16}$ of an inch, which usually lay buried in the deposit of coarse particles which commonly collect in the box until removed. This deposit, even when very slight, was found to seriously impair the efficiency of the magnet.

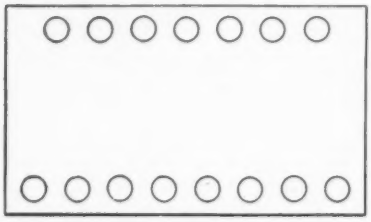


Fig. 1.

It was known that the magnetization was 80 per cent higher for wrought iron than for malleable iron and accordingly the malleable plates were replaced with wrought iron plates. So great was the improvement that a rough and ready attempt to measure the difference was made. A piece of one-inch wrought iron pipe, a trifle shorter than the width of the magnet box, was provided with a loop of cord through it, long enough to pass over the top of a postal scale held by hand. On gradually forcing the scale upward, the pressure necessary to overcome the pull of the magnet could be read off the dial of the scale. After repeating this a few times, the readings became more constant.

Under the same conditions of magnetic induction, the malleable iron plates required a pull of three and one-half pounds, and the wrought iron plate six pounds to break contact, an increase of 71+ per cent.

A further improvement of more marked effect, as regards the efficiency of the magnet, was worked out. The finer particles of metal in a viscous fluid, such as slip, are little influenced at even a very small distance from an excited pole. It was thought that if, at the ends of the wrought iron plates, fingers were to project upward to a height equivalent to the depth of the slip in the magnet box, much good would ensue, because the fingers

[1] Received June 5, 1922.

would then become the pole terminal and would carry the most powerful part of the magnetic field into the slip itself. Other advantages are that the fingers break up the body of slip which must pass between them, and that the settlings do not cover the best part of the field.

The effects of these changes were quite remarkable as the fingers being staggered caused the slip to flow in a sinuous passage along the magnet box.

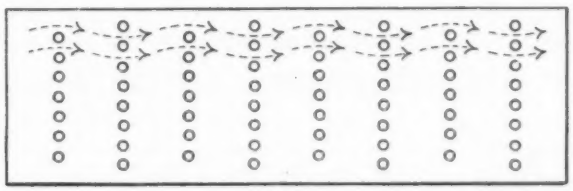


FIG. 2.

Fig. 1 is a plan of the plate, the direction of flow being transverse to the actual length of the plate.

Fig. 2 is a plan of the magnetic box indicating the sinuous course taken by the slip as it is divided by the fingers. This course is not imaginary but is very evident when the slip is flowing.

In the first trial only one plate was put in with the fingers, the result, however, was so good that a full set was made up and has been doing excellent work for nearly a year.

SQUARE D CO.
PERU, IND.

THE CONTROL OF BISCUIT LOSSES[1]

By Ira E. Sproat

ABSTRACT

The effect of the transverse strength and the moisture content of the body on biscuit losses is discussed. A transverse strength of 280 pounds per square inch and minimum moisture content produce the best results.

The analysis of the damaged ware and the brushers report gives data of great value in decreasing the biscuit losses, under given factory conditions.

Introduction

The subject of biscuit loss and its control is one of great importance to the average general ware manufacturer; especially is this true during the present period of keen competition and the downward trend of selling prices.

The Human Element.—Perhaps the most important factor affecting the biscuit losses is the "Human Element." It has become increasingly important during the last five years due to the demand for production. But one needs only to read the discussion of Herford Hope's paper on "Biscuit Losses"[2] to learn that the "Human Element" was also a very important factor in 1906 as it now is. In fact it will always be an important factor. It is quite evident, therefore, that any method of control must take the "Human Element" very largely into consideration if it is to prove of any value.

After trying a number of different methods of control during the year 1919, we finally decided on the following three-fold control:

1. Transverse Strength of Body in the Clay State.
2. Biscuit Loss Analysis.
3. Analysis of Brushers Report.

During the past two years this method has been followed closely and we are certain the results have justified its use.

Transverse Strength of Body

It has always been a well known fact by potters that one of the best ways to decrease the biscuit losses is to increase the amount of ball clay in the body. The strength of the body in the clay state is thus increased and the effect of careless handling of the ware (the Human Element) decreased. There is, however, no published data on the relative effect of the varying strengths of bodies upon the biscuit losses. We thought it advisable to determine the modulus of rupture of our body for a period of several years and then compare these results with the biscuit losses for the same period, in order to determine what relation the one had to the other.

[1] Received May 10, 1922.

[2] *Trans. Amer. Ceram. Soc.*, **8**, 62, 1906.

Transverse strength tests of the body direct from the pug mill were made twice a week, the average of these two tests being taken as the weekly value. The results of these tests for the past three years are shown on the upper curve of the accompanying curve sheet.

The biscuit loss in per cents is also given for the same period on the same curve sheet; the fine dotted line represents the daily losses, while the lower heavy line, the weekly averages.

When studying these curves it must be remembered that the modulus of rupture curve is several weeks in advance of the biscuit loss curve, due to the time required to make the ware and put it through the biscuit kiln.

From the 22nd week of 1919 to the 30th week in 1921 inclusive the following body was used:

Flint	34.0%
Feldspar	14.0
Edgars Florida	7.5
English China Clay	27.5
English Ball	17.0
	100.0

The great variation in strength of this body during the above period was due to the use of several kinds of English Ball clays and also to marked variations in the physical properties of different shipments of the same clay.

Specific attention is called to the high strength (300 pounds per sq. in.) of the body during the latter part of 1921. This was due to the substitution of 21% of "Hercules" clay for a portion of the English Ball and China clays in the formula just given. The maximum transverse strength obtained with English clays was only 260 pounds per square inch. Perhaps greater strengths could be obtained with these clays but color would have to be sacrificed and warpage would be materially increased.

From a study of the modulus of rupture and biscuit loss curves it can be readily seen that the *biscuit losses decrease with every marked increase in strength up to 300 pounds*, and *vice versa*. Therefore, decided changes in the modulus of rupture of a body is a sure indication that there will be an inverse change in the biscuit losses within a week or so, all other factors being equal.

From a further study we see that a modulus of rupture of 200 pounds will give a biscuit loss of about 7.0%; 225 pounds, a loss of about 6.0%; 250 pounds, a loss of 5.0%; 275 pounds a loss of 4.0%; and 300 pounds, a loss of about 3.5%. In other words the biscuit loss can be decreased about 1.0% by increasing the transverse strength 25 pounds per square inch, or 2.0% by a 50 pound increase in the strength, etc.

We also found that a *body with a modulus of rupture of over 300 pounds*

had poor working qualities. It was too tough to flow readily when batted out or when formed into a piece of ware by the jiggerman, therefore, causing a greater biscuit loss than in a body having less strength.

The writer is of the opinion that a modulus of rupture of 280 pounds per square inch will give the best results under all conditions of manufacture. It must be remembered, however, that under some factory conditions, especially in those plants where quantity production is of secondary consideration, a modulus of rupture of 280 pounds will produce a biscuit loss far below the 3.5% noted above. In other words in those factories where more time and care is taken in handling the ware, a biscuit loss of 1.0% to 2.0% is no mere dream.

Moisture Content

Another factor to be considered is the amount of moisture the ware contains when it is removed from the molds. For a piece of ware which has a transverse strength of 300 pounds per square inch in the bone dry state, has a strength of only about 180 pounds when it contains from 3.0% to 10.0% moisture. All the moisture therefore would be expelled from the ware before it is handled.

Since very little ware being made today contains less than 3.0% of moisture, there is a great need for improved types of stove rooms in the general ware industries.

Biscuit Loss Analysis

Any method devised for the purpose of analyzing the damaged ware from the biscuit kilns, must necessarily meet the following three principal requirements.

First.—It must not require too much time as it is advisable to make an analysis daily. All the damaged ware from the kilns can not be inspected daily, as this would require too much time. Only one class of ware should be analyzed daily.

Second.—The analysis should be made on that class of ware which is coming through the kilns daily in large quantities and in which the biscuit loss is the highest on the average. Seven-inch plates fill these requirements.

Third.—The classification of the various types of damages should be such that there would be no question as to how the damaged piece should be classified. After careful study and testing for months we have found the following classification satisfactory for this analysis:

1. Nipped
2. Warped
3. Rim Cracked
4. Foot Cracked

5. Bottom Cracked
6. Dunted
7. Sympathetic Dunts

The above classification may be further simplified by combining 3, 4 and 5 into one group called clay cracks.

It is not the purpose of this report to discuss the great number of different types of cracks and their causes, but in order that the reader may more fully understand the above classification a brief description of each type is given.

1. Nipped.—A piece of ware is classed as "nipped" if it is not cracked or warped. Cause.—Careless handling.

2. Warped.—All ware not cracked but warped is classed in this group. Cause.—Too high a ball clay content, too high and rapid firing.

3. Rim Cracked.—A piece of ware is classified under this heading if the crack is wider at the rim of the plate than in any other portion. Cause.—Too weak a body: Careless handling.

4. Foot cracks.—Cracks which show a greater width at the foot of the piece of ware are called footcracks. Cause.—Too weak a body, or careless handling; too green when taken off molds.

5. Bottom Cracked.—A plate which is cracked in the bottom is classed in this group. Cause.—Too weak a body; careless handling, or too green when taken off the molds.

6. Dunted.—A piece of ware is classed as dunted when it shows a fine circular hair line crack and the entire surface of the crack is smooth. Cause.—Too rapid cooling.

7. Sympathetic Dunts.—All ware which shows the characteristic circular hair line crack of a dunt but the entire surface of the cracked portion is not smooth are classed as sympathetic dunts. Cause.—Too weak a body: poor pugging: occluded air: careless handling.

The damaged seven inch plates, thrown out by the brushers, are inspected and sorted according to the above classification. The number in each of the seven groups is counted and recorded as percentages of the total number of plates brushed.

But such data would be of very little value unless we had some way of knowing when we were having an excessive loss from one of the above causes. This brings us to the consideration of the normal percentage for each of the above classifications.

Normal Percentages.—The normal percentages which we found to apply to our factory conditions during 1919, 1920 and the first half of 1921 are given in the following table.

The method used in obtaining these figures was as follows: Over 10,000 damaged seven inch plates, taken from burns in which the loss was normal, were inspected and classified, the average figure taken as the normal.

These normal percentages are nothing more or less than a guide by which we are able to tell when we have an abnormal loss in any one of the above groups, and thereby determine the cause in the shortest possible time.

Nipped	0.577%
Warped	0.534
Rim cracked	1.138
Foot cracked	0.418
Bottom cracked	0.314
Dunted	0.957
Sympathetic dunts	1.562

An analysis of the damaged seven inch plates from a given burn is as follows:

Nipped	0.731%
Warped	0.522
Rim cracked	1.164
Foot cracked	0.400
Bottom cracked	0.328
Dunted	2.100
Sympathetic dunts	1.495

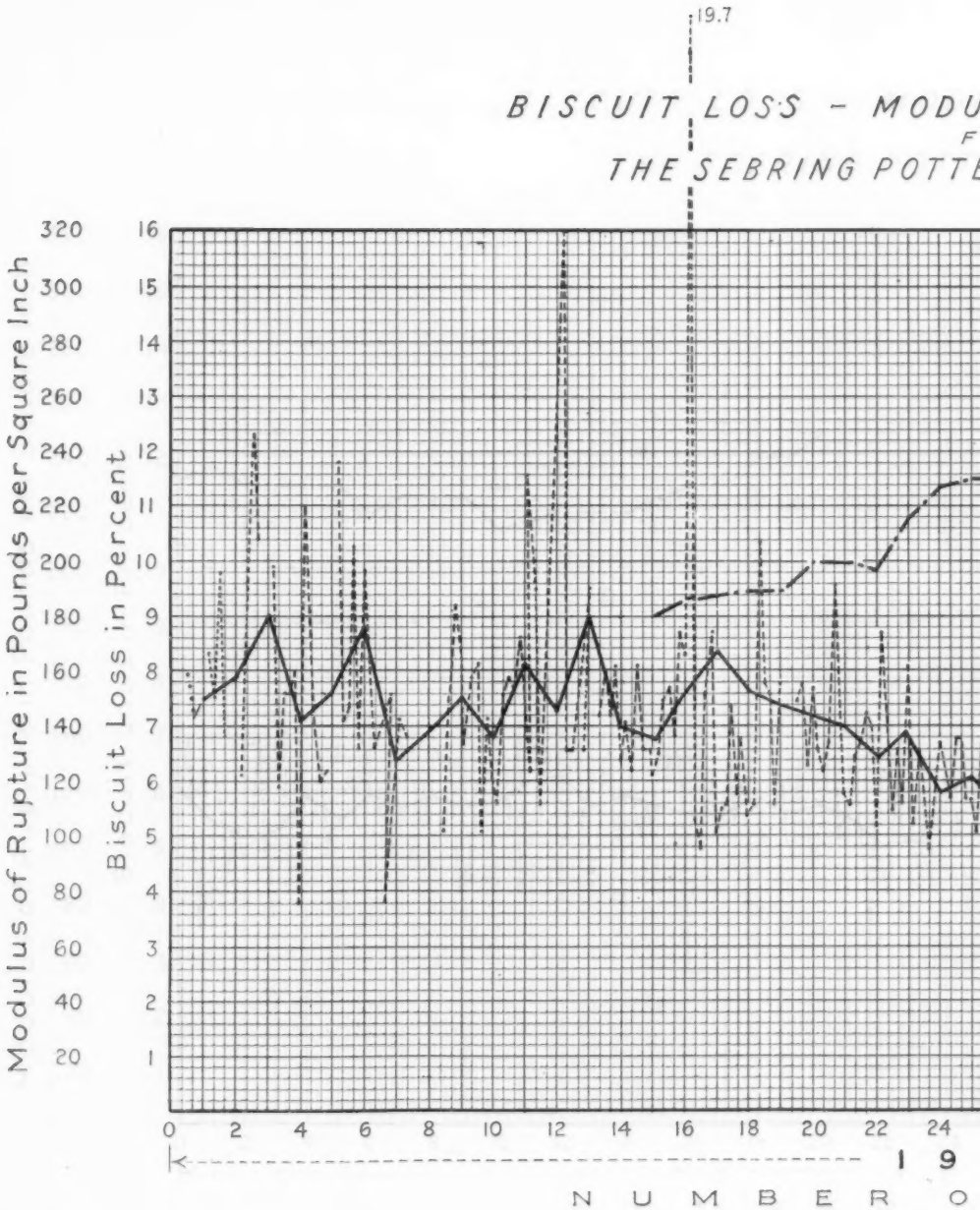
By comparison against the normal percentages, it is seen that the percentages of nipped ware and dunted ware are too high in this burn.

It must be remembered that the above normal percentages apply only to the conditions under which they were obtained, and may not apply to any other factory. As a matter of fact conditions in the same plant may be so changed as to materially affect these normal figures as was the case during the last half of 1921, when a radical change was made in the body composition. The normal percentages in use now with this new body are as follows:

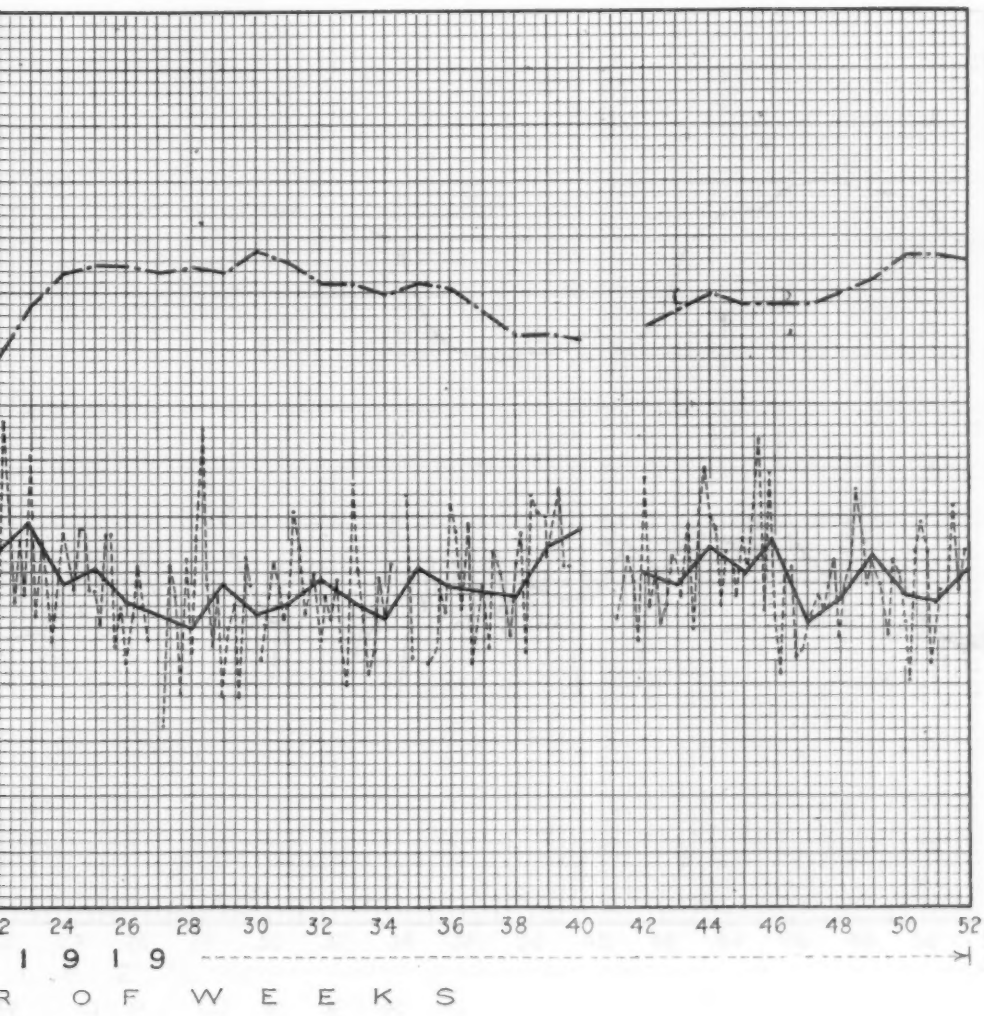
Nipped	0.438%
Warped	0.664
Rim cracked	0.742
Foot cracked	0.175
Bottom cracked	0.157
Dunted	0.704
Sympathetic dunts	0.620

Comparison of these normal percentages with the former set shows that by increasing the strength of the body in the clay the percentage of nipped and cracked ware is decreased but the percentage of warped ware is increased. The decrease in percentage of dunted ware was due to a decrease in the cooling time.

The purpose of the biscuit loss analysis is to determine as quickly as possible the cause of high losses which are common to all classes of ware,

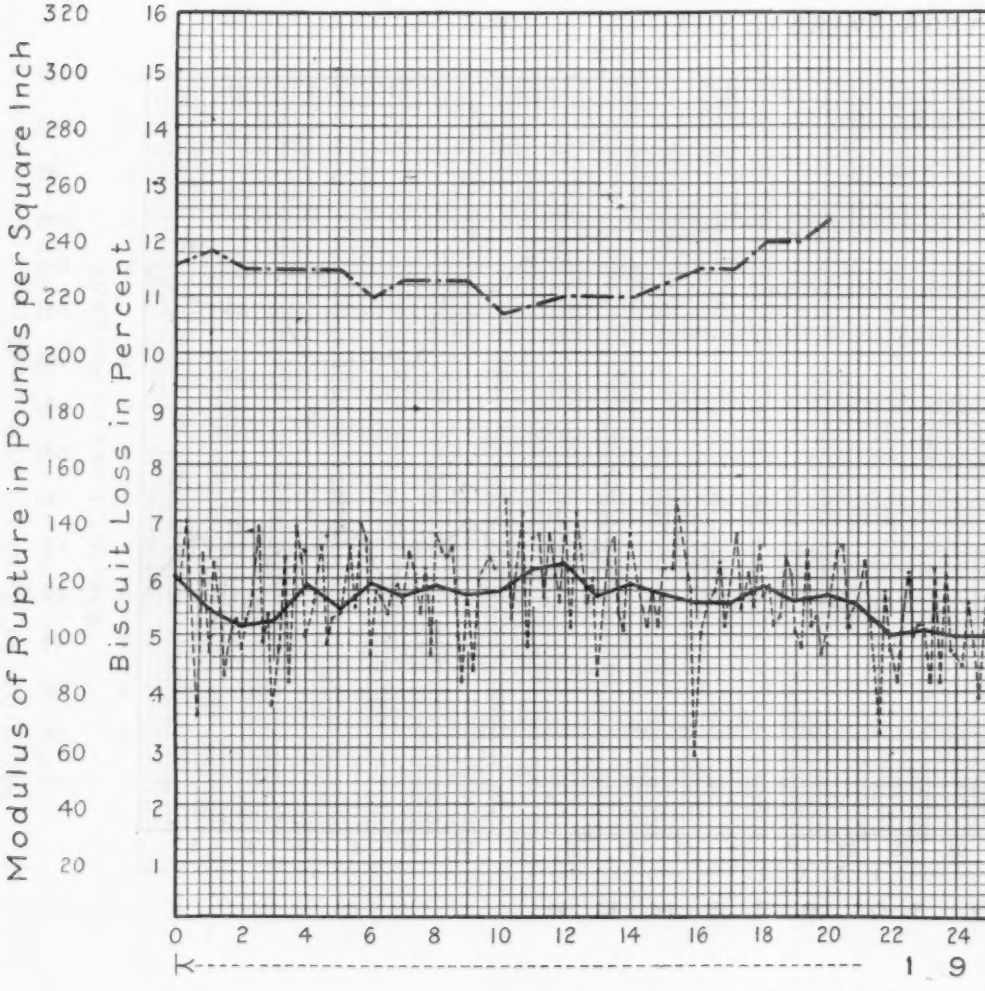

19.7
BISCUIT LOSS - MODU
F
THE SEBRING POTTE
Modulus of Rupture in Pounds per Square Inch
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
Biscuit Loss in Percent
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
2
4
6
8
10
12
14
16
18
20
22
24
1 9
N U M B E R O

MODULUS OF RUPTURE CURVES
FOR
POTTERY COMPANY'S BODY

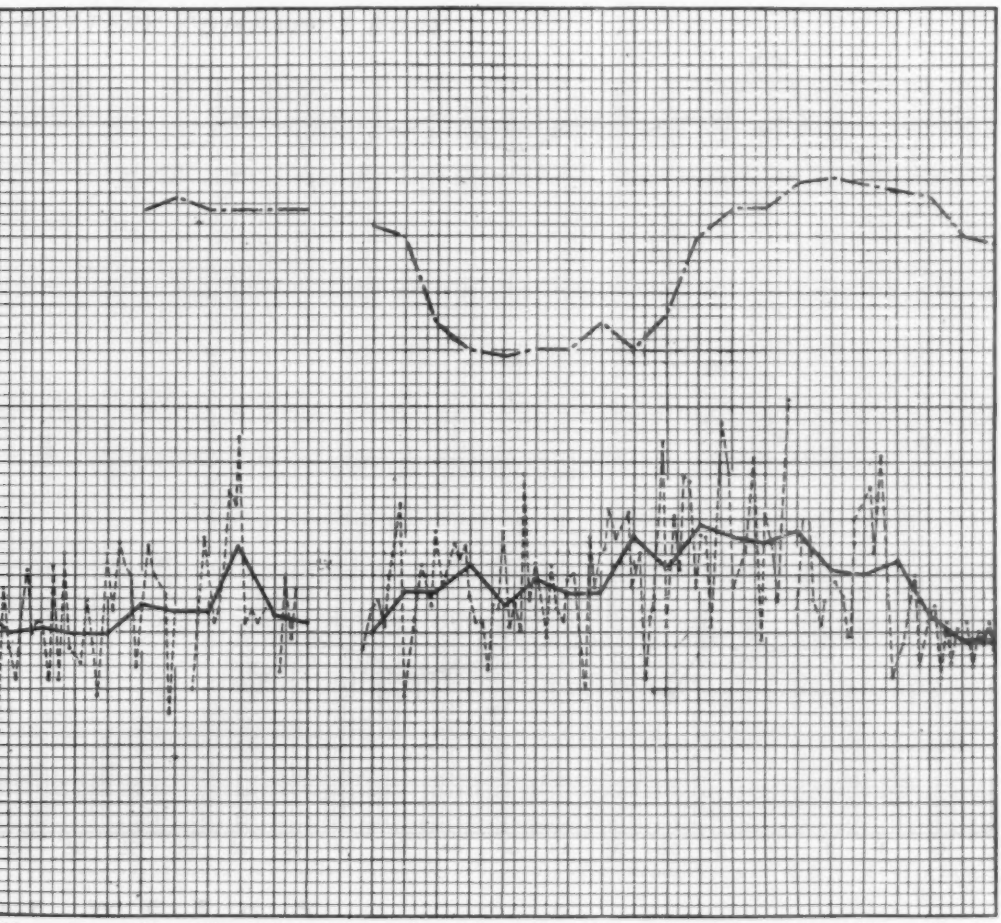


BISCUIT LOSS – MOD

THE SEBRING POTT



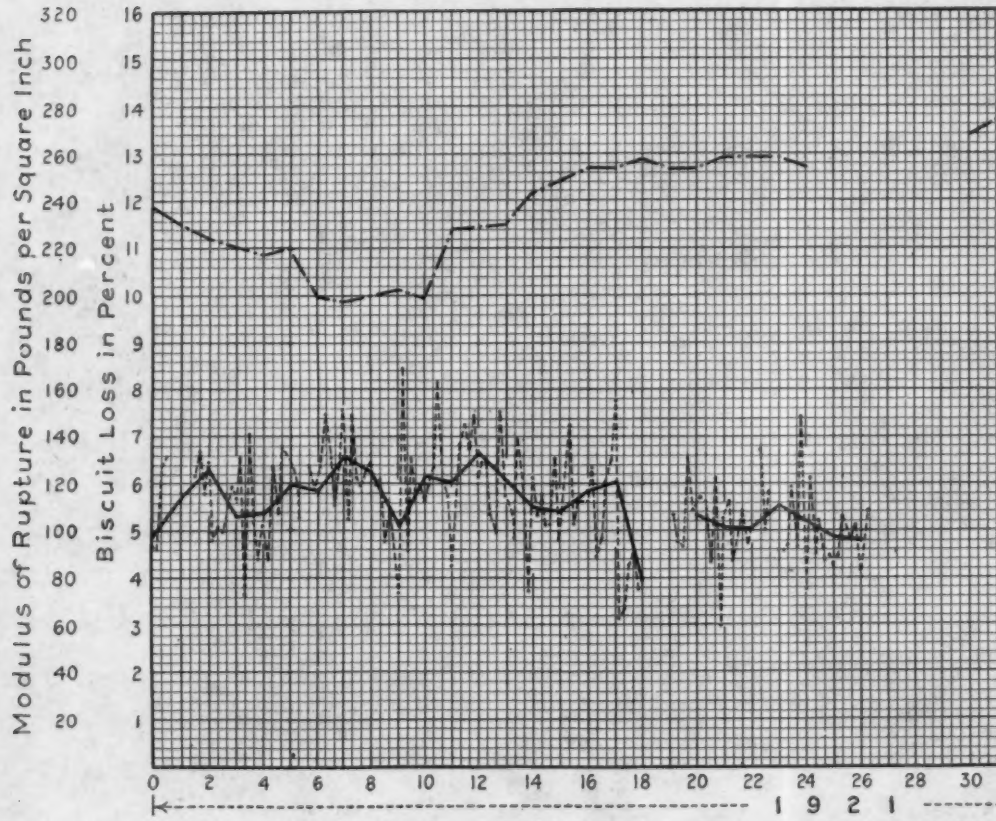
MODULUS OF RUPTURE CURVES
FOR
POTTERY COMPANY'S BODY



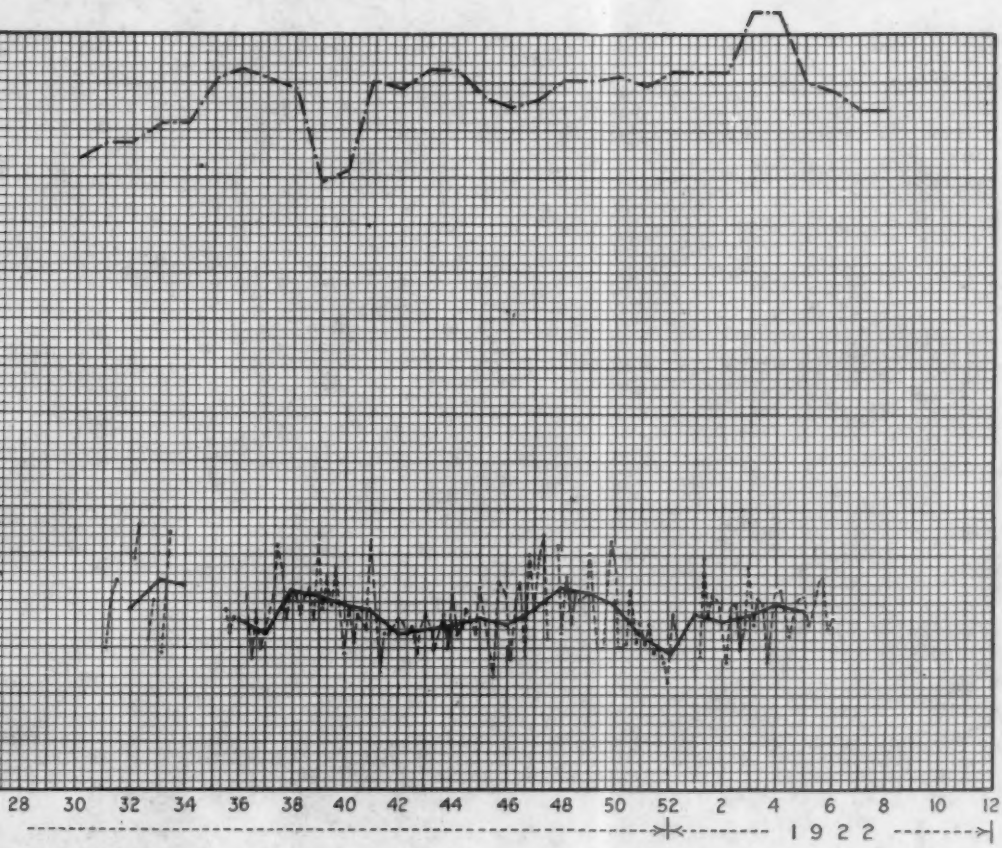
BISCUIT LOSS – MODU

F

THE SEBRING POTT



MODULUS OF RUPTURE CURVES
FOR
POTTERY COMPANY'S BODY



F W E E K S

and apply the cure before they become chronic. This analysis will not take care of the special causes of damaged ware which may be local and found in one class of ware only.

Analysis of the Brushers Report.—In order to make the control of the biscuit losses complete there must be some means of watching the peaks in the daily losses, and decrease them before they become general. The brushers report is excellent for this purpose, but it is necessary to have the percentages of loss of each class of ware brushed figured and ready for study by 9 A. M. of the day following date of report. Unless the percentage of loss of all damaged ware is figured each day, it is useless as a guide for control.

All damaged ware sorted out one day should be ready for inspection on the following day. Then if a given class of ware shows an abnormal loss, the damaged ware is available for inspection and study.

Summary

The chief factor in the control of the biscuit losses is the transverse strength of the body in the clay state. If the modulus of rupture is maintained at 280 pounds per square inch the effect of careless handling of the ware is offset, and the Human Element automatically controlled. The effect of the Human Element is also made less effective by not taking the ware off of the molds until it is bone dry.

A daily analysis of the damaged seven inch plates will give early indications of such chronic troubles as, too weak a body, careless handling, improper firing, or too rapid cooling of the kilns.

Special losses such as edge cracks, cup handles coming off, etc., can best be detected and controlled from an analysis of the brushers report.

The writer acknowledges his indebtedness to Mr. C. L. Sebring for advice and assistance in this investigation.

SEBRING POTTERY CO.
SEBRING, OHIO

NOTE ON THE EFFECT ON MANGANESE IN GLASS MELTED UNDER REDUCED PRESSURE[1]

By E. N. Bunting

The decolorizing action of manganese is destroyed by melting and fining glass at 1400°C under a pressure of 0.03 atmosphere. The decolorizing oxide, Mn_2O_3, is decomposed[2] under these conditions into MnO and O_2.

We have fined several small pots of glass in an electric furnace[3] in which the pressure can be gradually reduced. As the pressure is lowered, the dissolved gases bubble out, decomposable oxides dissociate, and the finished glass assumes the ordinary light green color, when cold, imparted by the FeO present. An interesting specimen was obtained in a melt in which the fining was incomplete, as the furnace winding burned out when the pressure reached 0.03 atm. The pot of glass turned out with the bottom 5 cm. colored light green, the 5 cm. mid-section colorless, and the top, about 2 cm. colored pink. The green section was free from bubbles, the colorless section contained many fine ones, and the pink top, more bubbles than glass. The glass contained 0.2% MnO and the manganese content of the three layers was the same.

The formation of the pink top layer was probably due to the high O_2 content of the gas in the bubbles, which before removal oxidized sufficient MnO to Mn_2O_3 to color the top glass pink.[4]

Ceramics Dept. U. of Ill.
Urbana, Ill.

Discussion

Mr. Hostetter:—Is there any discussion on this interesting experiment of melting glass in vacuo?

Mr. Wright:—I would like to ask Dr. Bunting if he has ever attempted to melt a glass containing selenium under reduced pressure?

Mr. Bunting:—No, we have not.

Mr. Wright:—Don't you think it is possible to obtain colorless glass, green glass, and pink colored glass when a tank is closed down if the glass contains selenium?

Mr. Hostetter:—Melted under ordinary conditions?

Mr. Wright:—Yes.

Note: No member had any definite views on this point.

Mr. Hostetter:—What is the effect, Dr. Bunting, of having arsenic in the glass?

[1] Presented before the Glass Division, St. Louis Meeting, Feb. 28, 1922.

[2] K. Honda and T. Soné, *Sci. Repts. Tohoku Imp. Univ.*, **3**, 139–52.

[3] *Eng. Expr. Sta. Univ. of Ill., Bull.* No. **118**, 12.

[4] S. R. Scholes, *Jour. Ind. Eng. Chem.*, **7**, 1037 (1915).

MR. BUNTING:—All volatile constituents keep boiling out.

MR. HOSTETTER:—I suppose this effect is really a substitute for arsenic?

MR. BUNTING:—It is.

MR. FORSYTH:—Was this specimen made in connection with the measurement of the particular gas?

MR. BUNTING:—No. The object was to fine the glass at reduced pressure.

A MEMBER:—Was there any oxidizing agent added?

MR. BUNTING:—No.

A MEMBER:—Was there any nitre used in the glass?

MR. BUNTING:—We do not know how the glass was made. It was furnished by the General Electric Company. They furnished an analysis but no batch formula from which the glass was made.

MR. HOSTETTER:—Perhaps Mr. Forsyth will tell us whether nitre was used or not.

MR. FORSYTH:—The batch probably contained nitre.

MR. HOSTETTER: Was that a lime glass?

MR. BUNTING:—No. It was a light flint.

BY E. W. TILLOTSON:[1]—I should like to inquire whether the author determined the course of the light green color of the bottom layer of this sample. It has been repeatedly observed (S. R. Scholes, *Vide supra* and *Jour. Soc. Chem. Ind.* **35,** 518(1916); Frink, *Trans. Am. Ceram. Soc.* **19,** 370, (1917); Tillotson, *Ibid.*, **19,** 375, (1917)) that a green color may be produced in glass by manganese which perhaps in this case is in the form of manganate (MnO_3). At least this green manganate color may be seen in the partially fused batch the composition of which is favorable for the formation of manganates.

In view of this the following explanation of the observed phenomena is offered. (1) The bottom portion is colored green due to an excess of manganate (MnO_3). (2) In the middle portion a part of the green MnO_3 is dissociated to the complimentary pink Mn_2O_3 so as to produce a "colorless" glass. (3) In the top layer the dissociation has proceeded farther giving rise to an excess of Mn_2O_3 and a decided pink color. The bottom layer was free from bubbles indicating no disengagement of oxygen; the colorless region contained a few bubbles indicating that dissociation had commenced; and the top layer contained many bubbles indicating a large disengagement of oxygen.

REPLY by Mr. BUNTING:[2]—The explanation offered by Dr. Tillotson is probably incorrect for the following reasons:— (1) While the glass is being

[1] Received June 30, 1922.

[2] Received August, 1922.

fined under the reduced pressure, the whole mass of glass is full of bubbles therefore it can not be said that there was no evolution of O_2 from the bottom layer. (2) Similar melts where the fining is more complete are wholly colored green. It seems to me very improbable that at a temperature of 1400°C *in vacuo* any MnO_3 would not have been reduced to MnO, as the dissociation temp. of MnO_3 is considerably below 1400°C.

REFRACTORIES FOR ZINC SMELTING[1]

By G. C. Stone

Introduction.—The refractories required in zinc smelting can be divided into five classes, depending upon the uses to which they are put: (1) Roasting Furnaces; (2) Oxide Furnaces; (3) Spelter Furnace Linings; (4) Retorts; (5) Condensers.

Roasting Furnaces.—Practically all of the roasting of zinc ore in this country is done in one of four types of furnace, the Ropp, or Cappeau, Zellweger, Spirlet, and Hegeler. The Ropp and Zellweger furnaces are largely used in the natural gas district of the Southwest. They are not hard on the refractories as the temperature is not high, there is very little corrosive action from the charge, and the traveling rakes are supported independently of the furnace bed. Under these conditions any reasonably good fire brick is satisfactory. The Spirlet furnaces have been used but little, and practically all of the brick used in them are special, and there is no published information regarding their requirements or performance. Probably the largest part of the roasting of zinc ores is done in Hegeler furnaces, and owing to their form a special trouble has developed with the refractories. These furnaces are very large, about 80 feet long, 17 feet wide, and 30 feet high. Everything is in two parallel sections. Starting from the bottom each section has regenerative chambers, and above, three gas chambers, seven roasting hearths and frequently special air passages. The arches from both set about on the center wall (Fig. 1). The life of the furnaces is long, as the temperatures are not excessive and there is but little corrosion or wear, but the load acting on the center wall, which is maintained at a relatively high temperature, causes it to settle badly. This settlement is very serious and is usually the cause of rebuilding of the furnace. It is not uncommon to find the inner side of the hearths five inches lower than the outer, which spoils the work, the ore tending to accumulate on the low side to such a depth as to retard its roasting and reduce the capacity of the furnace very materially. This irregularity is most noticeable crosswise of the furnace, but the middle is also lower than the ends, which causes irregularity in the movement of the ore. This excessive and irregular settling is apparently due to two causes. The irregularity is due mainly to the difference in temperature of the outside and center walls. The settling is mainly due to the shrinkage of the brick on account of their not having been burned long enough at a sufficiently high temperature. A contributing cause in many cases is the irregularity of the thickness of the bricks used, which necessitates heavier joints than are desirable, as the mortar shrinks more than the brick. It should be possible to burn brick so that even long-continued heating

[1] Received June 27, 1922.

to a temperature of about 850°C (1560°F), and never exceeding 900°C (1650°F) would not cause a shrinkage of from one to three per cent.

Oxide Furnaces.—The refractories in furnaces making zinc oxide have to stand a fairly high but by no means excessive temperature, with

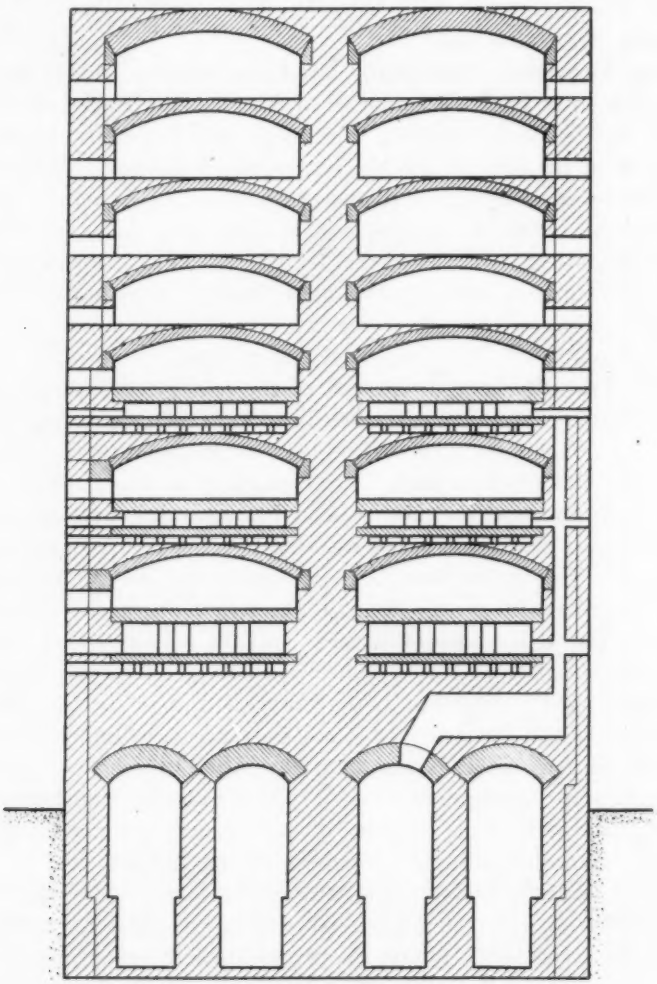


FIG. 1.

sudden drops by air cooling when the furnaces are cleaned out and charged every six or eight hours. In addition, when the ores contain much lead there is very severe corrosion from the lead fumes, particularly in and around the openings in the arch through which the gases and vapors discharge. With good brick, well laid, a furnace working lead free ores should

last from three to four years. With leaded ores the life is much shorter. Much depends on the design, and the life can be considerably increased by using properly designed special shapes. The temperatures are not excessive, about 1000°C (1400°F), but the frequent changes of temperature and rather severe handling in breaking up and removing the charge often damage the brick. We have found dense, hard-burned brick the best. In this case, as in most others, it is easier to get the necessary qualities in a brick that will not stand a much higher temperature than it is to be used at than in a more refractory one.

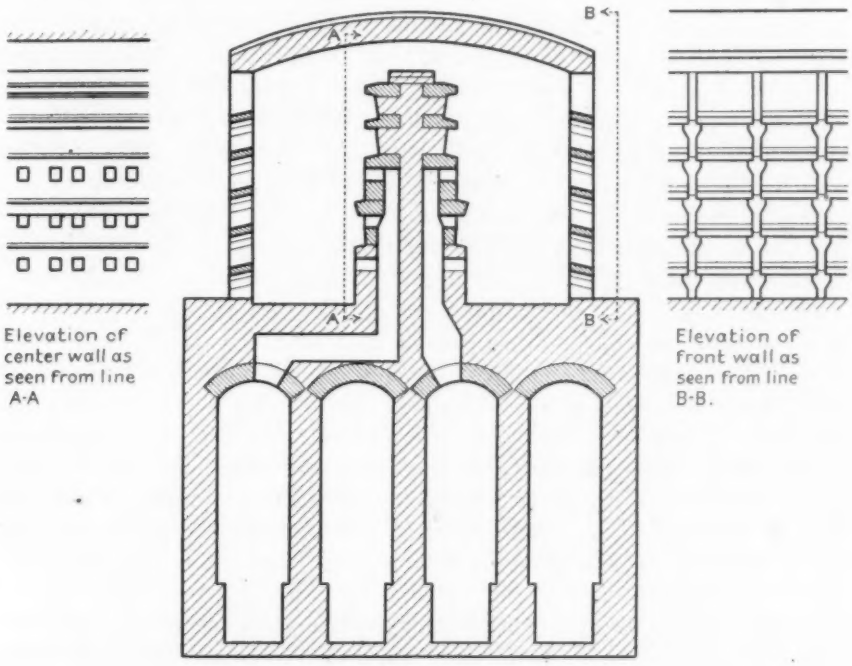


FIG. 2.

Spelter Furnace Linings.—Spelter furnace linings have to stand a high temperature for long periods, with a regular daily variation between about 800° and 1400°C (1400° to 2500°F). When the furnace is being charged in the morning the gas is shut off, and the temperature drops to the lower limit; it is then gradually raised to the upper one, and kept there for about six hours. The furnace is then cleaned out and recharged. In addition to the high temperature more or less coal ash is carried in by the gas, and slag from broken retorts gets over the inside of the furnace. Owing to its peculiar functions, practically the whole of the lining is made of special bricks, many of which are very large (Fig. 2). These very large bricks

are very difficult to dry without warping and cracking, unless they are either made very porous or dried very slowly. The former gives a poor block and the latter is expensive. In consequence we have not been able to buy nearly as good linings as we make. When tried under the same conditions, our own make of block lasts at least three times as long as the best we have been able to buy. Some of the lining blocks, notably those called plates, are subjected to relatively large transverse loads. In a properly designed furnace these can be replaced, but doing so is troublesome and causes an expensive loss of time. The brick walls give trouble from shrinkage, like the center walls of the roasting furnaces, but in regenerative furnaces this can be compensated for by making the back wall a little higher than it should be at the start, so that the shrinkage leaves it at about the proper height. What is required is a brick that will stand the temperature and be close grained, strong and sound.

Retorts.—The retorts are tubes with one end closed, and are from four to five feet long. The section is either circular, from seven to ten inches in diameter, or elliptical, from 6 x 9 to 8 x 15 inches. The walls are about one inch thick. They are nearly always made in hydraulic presses and immediately placed in the drying rooms, where they are kept until used. The general practice is to keep retorts for at least three months before burning. Most spelter men prefer to keep their retort longer than this when possible. The retorts are burned as required in small kilns, placed close to the furnaces, and are put in the latter while red hot. Under such conditions it is obvious that they must be made at the plants where they are to be used, and practically all of the smelters have learned how to make reasonably satisfactory retorts. Their life is from 30 to 40 days. The term life is apt to be misleading, as they are often discarded because they are filled up with slag and not because they have given out.

Retorts should be capable of standing a temperature of 1600°C (2900°F) without deflecting materially when supported only at the ends, with a clear span of about four feet. They must be dense, so as to be impervious to gases and zinc vapor. Porosity, if caused by enclosed spaces that do not communicate with each other is not as detrimental as fine cracks running through the walls. The material from which the retorts are made must not be easily attacked at the furnace temperatures by the impurities in the ore worked, or by zinc vapor. The last condition, susceptibility to attack by zinc, has not been studied to any extent, but is important as old retorts are always colored purple by this reaction and are brittle. Thin sections of such retorts show crystals of spinel which have been formed.

The reaction by which the spinel is formed is rather obscure and has not been much studied. The reacting bodies are silicate of alumina

metallic zinc as vapor, and in addition there must be oxygen. It appears to me that the latter is supplied by the dioxide of titanium, TiO_2, in the clay, and that the reaction probably is as follows:

Al_2O_3, $3SiO_2 + Zn + 2TiO_2 = ZnO$, $Al_2O_3 + 3SiO_2 + Ti_2O_3$.

Both zinc spinel and titanium sesqui-oxide are purple. The volume of the products calculated from their gravities is greater than that of the reacting bodies, which would account for the slight swelling and marked weakening caused by the reaction. A careful study of the conditions effecting the production of zinc spinel would, I believe, be of value.

Condensers.—Condensers are also always made by the smelters, but there is no reason that they should not be made by the manufacturers of refractories. They are usually clay cones, 16 to 20 inches long, about two inches in diameter inside, at the small end, and six at the large, with walls about $^5/_8$ of an inch thick. They are not subjected to a high temperature, not over 600°C, (1100°F) but they get rather rough handling as they are taken down and scraped out each morning. They should be impervious to zinc and zinc vapor and strong enough to stand rough handling. The cost of condensers is a relatively small part of the smelting cost, and there is a much greater difference in their quality than in that of the retorts.

General.—The refractories used in zinc smelting should be able to stand the temperatures to which they are to be subjected, and these temperatures are known, so that they can be specified for the particular cases.

All refractories should be as dense and strong as possible. This not only minimizes the attack by slags, but makes them impervious to zinc vapor, which is a frequent cause of damage.

They should be true to shape and dimensions. In most cases exactness in length and width is not as important as uniformity in thickness, as it is obvious that if the brick in a course vary much in thickness the joints will necessarily be thicker than they should be, and will either shrink and open up, allowing attack by slag and gases, or the walls will settle and cause trouble. For the same reason the top and bottom surfaces must be flat.

The troubles with refractories are not all due to the latter. Many furnaces in use are badly designed, and changes in the shapes and positions of the blocks would increase their life in many cases. The brick are often blamed for defects when the short life is due to poor brick laying and not to poor brick. From my own observation I should say that less than 5% of the brick used are laid in a manner calculated to give the best results, and fully half are very badly laid.

NEW JERSEY ZINC CO.
NEW YORK CITY

PRELIMINARY REPORT OF THE COMMITTEE[1] ON FUEL CONSERVATION ON THE RAILROAD TUNNEL KILN

The program adopted by this Committee covered two investigations considered most important to the members of The Refractories Manufacturers Association with reference to the conservation of fuel. The first of these investigations had for its object the determination of the ability to reduce fuel consumption with the present kiln equipment and the second, the determination of the value of the railroad tunnel kiln to this particular industry. This report will deal with the tunnel kiln.

The industry, we believe, realizes the fact that manufacturing costs must be reduced and, as the cost of burning the ware is one of the largest items entering into cost, it will be realized that any reduction in this item would be decidedly advantageous.

The ceramic industry has for many years wasted far more fuel than any industry in the country. Any method or apparatus, therefore, that could be developed to make the firing of ceramic wares more efficient should be a very welcome thing, not only to the industry but to the country at large.

It should be explained that in the firing of ceramic ware in periodic kilns the greatest fuel losses are in the heat carried out of the kiln in the highly heated combustion gases; the heat radiated from the exterior of poorly insulated side walls and crown arch and the heat left in the ware and kiln structure at the end of the burn. The average losses, as calculated from carefully conducted tests, are shown below:

Heat taken up by ware	12%
Heat lost in combustion gases	25%
Heat lost in ashes	4%
Heat taken up by kiln and lost by radiation	59%

If the necessary means were employed, a large part of the first expenditure could be reclaimed. A regenerative or recuperative provision would greatly reduce the second loss, while a thorough heat insulation of the structure would reduce the radiation loss materially.

Part I

The Continuous Car or Railroad Tunnel Kiln

With the idea of reducing the heavy heat losses noted, there has developed a kiln structure, known generally as the "Continuous Car Tunnel Kiln," or the "Railroad Tunnel Kiln." With the use of this type of kiln, the fuel consumption is only from 15 to 30 per cent of the average periodic kiln requirement and, therefore, other things being equal, the tunnel

[1] Refractories Manufacturers Association.

kiln is going to take a very prominent part in the future firing of ceramic wares.

In this type of kiln the ware is mounted on iron or steel cars having refractory platforms. The entire length of the kiln is filled at all times with a train of these cars, which keeps moving almost continuously from the charging end toward the discharging end. A series of furnaces are provided on each side of the kiln approximately midway of its length and the combustion gases from these furnaces pass immediately into the tunnel proper and come into direct contact with the ware setting. These gases then proceed toward the draft ports near the charging end of the kiln—traveling in a direction opposite to the movement of the cars. Fresh air from the pressure fan is introduced through a blast head just underneath the kiln crown at the discharging end. This air, which is introduced largely for cooling purposes, takes the heat from the fired ware and upon reaching the furnace section of the kiln functions as secondary air for combustion—mingling with the combustion gases from the furnaces and proceeding with these gases to the draft ports. From this it will be seen that if the kiln has sufficient length, the combustion gases will leave the kiln at a relatively low temperature. Furthermore, the ware leaving the kiln will have given up most of its heat to the incoming fresh air. The only other heat loss of any consequence is radiation, which is probably taken care of in a better manner than is done on any other kind of ceramic kiln, *i. e.*, at the center or high temperature section of the kiln, where the walls and crown have heavy insulation; the intermediate portions are insulated to a lesser degree and the ends are only slightly insulated.

History

This kiln originated in Europe—the first one appearing at Vincennes, France in 1751, and was used for firing overglaze colors. The first kiln of this type proposed for firing brick was covered by a Danish patent in 1840. This was followed by a kiln which was described in a German publication in 1848, and consisted of merely the heating end and the combustion compartment, but no cooling end. When the ware had passed through the high temperature zone it was removed and placed in another tunnel, or compartment, to cool. Other designs embodying various ideas of construction were then brought out, some of them not differing greatly from the modern kiln.

In 1877, Otto Bock was granted a German patent and he built about sixty of these kilns—most of them proving failures. Within the last fifteen years or so more successful kilns have been developed, particularly the kiln of the Faugeron or, as it is known in this country, the Didier-March type; a number of these are now in successful operation in Europe and America.

The American history of this type of kiln seems to start with a kiln erected in Chicago about 1889 by J. C. Anderson for the firing of dry-press brick. Mr. Anderson took out two patents about this time, both pertaining to the twin-tunnel type. He soon built another kiln at Long Island City, but neither kiln operated for any great length of time. In 1910 two kilns of the Faugeron type were built at Keasbey, N. J., and as these kilns are still in operation, it can probably be said that they were the first successful kilns built in this country. About the same time several kilns of this type were built by Mrs. Shaw, one of them at Atlanta and another at Savannah, both of them proving absolute failures. The muffle type of kiln was introduced to this country from England about 1915 and has been attended with considerable success, particularly in the burning of white wares. Other kilns have been brought out from time to time—some admitted failures and others with varying degrees of success.

A large number of patents have been issued in this country on tunnel kilns which have never been built. Up to the middle of 1919, the records of the United States Patent Office indicated that at that time there were in force sixty-three patents relating to tunnel kilns and about as many more which had expired.

At the present time the available records would indicate that the following list covers the kilns erected and in more or less successful operation:

Direct-Fired Type:		
	Harrop Kiln	8
	Owens Kiln	13
	Russell (Zwermann) Kiln	5
	Didier-March (Faugeron) Kiln	7
Muffle Type:		
	Dressler Kiln	21
Miscellaneous:		
	Private Designs	7

Modern Development

In order that a better understanding may be had of the design, construction and operation of one of these kilns, the following description is given. This description covers a kiln of the direct-fired type which will not be named in this preliminary report. It is, however, a new and successful kiln and can be accepted as typical.

The kiln is used for firing a general line of low tension electrical insulators of both white and brown color. It is of the direct-fired type, and is equipped for using either natural gas or fuel oil or both together. The kiln proper is 4 ft. 6½ in. wide by 321 ft. long and holds fifty-two cars at one time. The setting of ware on each car occupies a space 4 ft. 2½ in. wide by 5 ft. 1 in. high by 5 ft. 9 in. long. A car is charged every hour and the train moves at the rate of 1.2 in. per minute. At the present

time, four furnaces out of eight are being fired. With this manner of handling, the ware is under fire for thirty hours; the cooling period is twenty-two hours.

Periodic kilns are usually either up- or down-draft. The tunnel kiln is essentially a horizontal-draft kiln. It is a well-known fact in physics that hot gases tend to rise, and if hot gases are introduced into a room or compartment of any kind, these gases will promptly rise and flow laterally in the upper portions of such compartment. In the case of the tunnel kiln the hot gases tend to rise and flow underneath the crown toward the draft ports near the charging end. The usual result of this is that the upper part of the ware setting is subjected to greater heat work than the lower part, which is very evident from the quality of the ware discharged. Recognizing these facts, there has been provided in this kiln structure obstructions to the free flow of gases underneath the crown and also, the side walls are so battered as to give greater clearance for the flow of gases at the lower levels than near the top. Furthermore, the ware, or the placing of saggers (clay boxes) carrying the ware, is stilted up off the car platform, which permits a circulation of hot gases underneath the ware. The result of this arrangement is that with the greater amount of circulation taking place at the lower levels, a uniformity of temperature is secured over the entire cross-section of the ware.

Firing losses (cull ware) in this design of kiln are practically eliminated, as all ware passes through the kiln at a uniform rate and all of it encounters uniform conditions of heating rate, maximum temperature and cooling rate.

Cars

The car frame is a single gray iron casting with a gridded top and with two double-flanged wheels and two flat-faced wheels—both kinds being 12 inches in diameter. These wheels are equipped with caged roller bearings and each revolves on an individual axle.

On each side of the car is attached a depending steel plate, $^3/_{16}$ inch thick, which runs in the sand-seal trough on each side of the kiln tunnel.

On top of the car frame is laid a No. 14 gauge steel plate, which supports a 2½ in. layer of Sil-O-Cel (pulverized kieselguhr) and Portland cement (4:1 by volume).

The car is then covered with specially shaped fire-clay slabs, 9 in. thick—the top surface being the finished platform.

Car Pusher

The hydraulic ram which is used to propel the train of cars through the kiln was designed by P. W. Ott and is far more simple and inexpensive than the hand-operated or mechanical device in general use.

This ram carries its oil for actuating in a reservoir in its own base. A single plunger oil pump, driven by a back-geared one-half horse-power variable speed electric motor is employed. The plunger has a stroke several inches longer than the car and returns automatically at the end of its stroke, through the operation of a trip and a special three-way valve.

This pusher operates under a pressure of 600 pounds per square inch and the total pressure necessary to move the train of cars is approximately 8,000 pounds.

Kiln Construction

Carrying the entire structure is a well reinforced concrete foundation 18 in. thick under the side walls. The outer masonry walls are preferably of soft burned porous common brick laid in cement-clay-sand mortar. The lining of the tunnel (arch and sides) and the furnaces are of the highest grade fire brick carefully laid in a minimum amount of fire-clay mortar. Between the lining and the outer wall is heat insulating material which will be spoken of later. Special fire-clay shapes are used wherever necessary, which results in a more solid structure and at the same time saves a considerable amount of the mason's time, which would otherwise be used in chipping and fitting.

A sand-seal trough is provided in each side of the tunnel—the outer confining wall of which is a $^1/_4$ in. by 8 in. steel plate, extending the full length of the kiln. These sand troughs, in connection with the sand-seal plates attached to both sides of the cars, provide an effectual air-seal between the tunnel proper (in which the firing takes place) and that portion of the tunnel beneath the car platforms. This seal is necessary, as it is quite essential that the hot gases from above are not drawn underneath the cars, to injure the running gear; and it is equally important that the draft in the tunnel proper does not draw cool air from beneath, to chill the lower portions of the ware.

Longitudinal slots are provided in the side walls, in which the car platform fits rather loosely. The purpose of this is to intercept radiated heat, which would otherwise travel from the highly heated tunnel proper down onto the metal car frames and sand-seals. Any number of furnaces may be provided on each side of the kiln, depending upon the length of the high-temperature (or soaking) zone required for the particular ware. In all cases these furnaces have hollow walls. Air is circulated through these walls and then led to the burners or through the grates as preheated primary air for combustion.

Air is also forced through a low, wide flue over the arch of the entire cooling end of the kiln. This air is then led down over the furnace arches and finally delivered into the front of the furnaces as secondary air for combustion.

The furnace throat or connection between the furnaces and the tunnel is the full width of the furnace and in height extends from about 6 in. above the car platform to a point about three-fourths of the way up to the spring line of the tunnel arch.

The charging end is closed by a Kinnear rolling steel door, having a hole in its lower part through which the push rod is inserted for moving the cars. After the train has been moved one car length, and the ram returned automatically to the starting position, the rolling door is raised and a car of ware is pushed into the empty space in the kiln. The door is then dropped, the push rod put into place and the pusher started.

Steel angles 5 in. x 3 in. x $^3/_8$ in. running the full length of the kiln, are provided on each side to take the thrust of the kiln arch. Vertical buckstays of 6-in. I-beams are spaced at approximately 6-ft. intervals along the sides of the kiln, being anchored at their lower ends in steel U-straps cast into the concrete foundation and held together at their upper ends with $^3/_4$ in. diameter tie rods passing through unfinished gray iron castings slipped over the tops of the I-beams.

The side walls are provided with small peep holes, having iron frames and covers, to allow an inspection of the interior of the kiln and ware while under fire, as well as of the pyrometric cones used in determining the real heat work being done in the kiln. These holes are also used for taking pressure and draft readings, as well as gas samples for analysis.

Insulation

As radiation is one of the large losses in periodic kilns, special care has been taken in this kiln to reduce this to a minimum.

The best non-conductor of heat at high temperatures that has been developed is kieselguhr (infusorial or diatomaceous earth). This is readily available now in its natural state under the trademarked name of Sil-O-Cel and can be gotten either in the form and size of standard fire brick or as powder. One inch in thickness of this material is equivalent in insulating value to 12 inches of ordinary fire-brick masonry. This material may be used in the walls in the form of brick or block, or as a powder. Powder is probably preferable, as it leaves no large voids or air spaces between the common brick wall and the fire-brick lining.

In the furnace or high temperature zone, the side walls have 4½ inches of heat insulating material. The arch in this zone is also covered with the same amount of insulation.

Toward the ends of the kiln the insulation is reduced to 2½ in. in thickness and at the extreme ends no special insulation is employed.

Expansion

Expansion of a masonry structure, due to the raising of the interior to high temperatures, is a very difficult thing to handle. The expansion and contraction of a periodic kiln are very hard on the structure. It can be readily appreciated, therefore, what a serious problem expansion is in a structure over 300 ft. long.

In this kiln, expansion joints are provided about every 50 ft. in the foundation, in the side walls and in the tunnel arch, the several joints not being permitted to fall in the same vertical plane. The expansion joints in the side walls are "ship-lapped."

In every fifth mortar joint of the common brick side walls are placed $^1/_{16}$ in. x 1 in. steel strips, so that when it becomes necessary to close down the kiln, the several sections of the kiln wall will contract as monoliths, rather than develop unsightly diagonal cracks.

The track rails have mitered, spaced joints and slotted bolt holes to take care of the expansion in these members.

Firing Equipment

Only four of the eight furnaces are being used in the kiln at this time, these being fired with natural gas.

A No. 3 Maxon Premix burner is installed in front of each furnace. These burners consist of a small centrifugal blower operated by a direct-connected one-half horsepower motor. Gas and preheated air are drawn into the blower, which thoroughly mixes the two and then delivers the mixture at a high velocity into the furnaces. About 90,000 cu. ft. of gas are consumed per 24 hours.

Equipment is also installed for the firing of fuel oil during periods of gas shortage. The low pressure system is used—the Maxon blowers supplying the air. The Viking rotary oil pump, operated by a direct-connected one-fourth horsepower motor, is used to supply the oil pressure. This pump has a capacity of 2½ gallons of oil per minute, delivered at 35 pounds pressure through a $^3/_8$ in. diameter pipe to the oil heater. The oil pumping and straining equipment is in duplicate, so that continuous operation may be assured.

Power

The draft fan is a centrifugal steel plate exhauster. The wheel is "overhung" and the shaft is provided with water-cooled bearings. A 10 horsepower motor is provided for this fan.

The centrifugal steel plate pressure fan, which supplies the air for cooling and for combustion, is operated by a 7½ horsepower belted motor.

Aside from the firing equipment, the total power actually required to operate the kiln is probably not in excess of 12 horsepower.

Pyrometric Installation

Electric thermocouples are inserted into the tunnel through the center of the arch—noble metal couples being used in the high temperature parts and base metal couples in those parts where the temperature does not exceed 1500°F. The cold end junctions of all thermocouples are buried in Sil-O-Cel in 12-in. square boxes, so as to prevent fluctuations in the pyrometer readings.

All pyrometer wiring is carried in conduits.

The instruments used are the wall type of indicating galvanometer and the recording galvanometer. The former is used in securing the temperatures for the gradient records and the recorder is used for checking up temperatures during the night and on holidays, to see whether the firemen have been watchful or not. It furthermore enables the firemen on .the different shifts to compete with each other in securing constant temperatures during their tricks, which is indicated by a straight, non-waving line.

Part II

The Committee has so far had the opportunity of visiting six plants operating railroad tunnel kilns and intends visiting two others before presenting its final report. A short description of the kilns visited follows.

Dressler Kiln Champion Porcelain Co. The operation of this kiln is extremely interesting on account of the fact that it is the only one in the country, so far as known, that is operating at from cones 18 to 20 down. In the first place it demonstrates that the highest temperatures required in this industry can be and are reached in this type of kiln.

The installation is, without a doubt, the best and most complete in the country and no item of expense has been spared that would make for perfect operation and results. The kiln is burning spark plug porcelains having a composition approaching that of Sillimanite; the ware is enclosed in saggers or refractory boxes.

The kiln is 305 ft. long and is fired with city gas. It holds 48 cars and ordinarily operates on a one hour basis, *i. e.*, one car is put into the kiln and one taken out every hour, making the total elapsed time a car is in the kiln, forty-eight hours. At the time of the visit of the Committee it was operating on a 1½ hour schedule.

Unlike other kilns this is the only one in the country which is operating without a sand-seal for the protection of the iron work on the cars. This kiln is equipped with a system of water cooling pipes traversing its entire length and extending from the rails to the top of the iron work on the cars.

The cars are of cast iron, equipped with roller-bearing trucks and can be pushed by one man when loaded with ware. They are lubricated with 600 W oil.

The kiln is equipped with a hydraulic ram for moving the cars through the tunnel and is also equipped with automatic control buttons which stop the cars should the pusher fail to stop its pushing action when the proper point has been reached.

On a 1½ hour schedule the products of combustion leave the kiln at between 480° and 550°F. This is lowered somewhat when the cars are traveling on a 1 hour schedule.

As this is a muffle kiln, none of the products of combustion come in contact with the ware and the atmospheric conditions inside of the kiln are under absolute control, either oxidizing or reducing conditions being maintained at the will of the operator.

This kiln being the first one to operate at high temperatures has been experimental so far as the refractory lining of the high heat zone is concerned. It has been down twice at six month intervals for repairs to the lining in this zone. The muffles are made of carborundum and it appears that this is the only refractory that will give satisfaction, although there is still a question as to whether the proper mix has been worked out. Originally the section of the crown covering the high heat zone was constructed of silica brick, all other sections being of No. 1 Missouri fire brick. After six months' operation, the silica section was found to be in perfect condition, while the sections adjoining at each end had settled to such an extent that it was found necessary to replace them. The replacement was made with silica brick and, after a further six months operation, they were found to be in perfect condition. This would seem to indicate that silica brick should be used in these kilns whenever possible where high temperatures are obtained.

As an indication of the up-keep cost of the muffle type kiln at the temperatures obtained, it is interesting to note that the refractory repairs have averaged, to date, from $700 to $1000 per month. In this connection it should be borne in mind that this kiln is the pioneer in high temperature work and that, as a result of the lessons learned, it can not be questioned that on future kilns the depreciation would be considerably reduced.

It is interesting to note that this company has already started construction on a Harrop kiln of the direct-fired type in which the same temperatures will be obtained. After a thorough investigation, the officials of the company are of the opinion that this kiln can be built for less than one-half the cost of the Dressler kiln; that their results will be equal and that the up-keep cost will be reduced to practically nothing. This kiln originally cost over $100,000. It was built during the period of peak prices.

Champion or Balz Kiln
Champion Ignition Co. While this kiln can not be used for the burning of refractories of the ordinary type, it is, nevertheless, interesting as a development of an entirely new principle which is bound to find its place in the ceramic industry.

There are two kilns at this plant, only one of which has been operating. This kiln was originally 60 ft. long, but there has since been added an additional 15 ft. on the cooling end. This addition, however, has a sheet iron roof and is really only a cooling compartment. The kiln is divided into three zones,—20 ft. to the heating-up zone, 20 ft. to the high fire zone and 20 ft. to the cooling zone. The tunnel is only 36 in. high and 32 in. wide. The cars have decks 48 in. long by 24 in. wide and are 15½ in. high.

The kiln is fired with city gas on the surface combustion principle, there being five burners on each side, the flame being directed toward the crown (which is composed of carborundum brick) and reflected on to the ware, which is set on open fire-clay trays.

These trays are stilted above the fire-clay decks of the cars by means of fire-clay blocks, the trays containing spark plug porcelains which finish at cone 16–17. Beneath the trays are burned glazed tile of the Faience type which finish at cone 3. As the trays are only about 1½ in. thick an idea of the difference in temperature between the upper surface which reaches approximately cone 16 and the lower surface which reaches approximately cone 3, can be gotten.

The kiln is equipped with a sand-seal and the cars are placed in it on a 48-minute schedule, the ware being completely finished in 12 hours. The cars move at a rate of one foot in twelve minutes, being operated by chain drag.

This company originally used down-draft potters kilns, burning coal. Their burning time has been reduced from four to five days to twelve hours, but there has been no saving of fuel cost on account of the substitution of city gas, at about 70c per thousand, for the old method of coal firing. The losses have been reduced, however, from 10 to 12% to 6 to 8%.

The new kiln at this plant embodies some new ideas which may be valuable in other types of tunnel kilns. The principal one of these is the construction of the kiln walls and crown on concrete piers supporting reinforced concrete beams. This leaves a clear space between the piers from the floor line to the height of the sand-seal and thereby gives complete circulation beneath the cars which will naturally keep the temperature of the iron car approximately that of the kiln shed. This kiln is 87 ft. long, 36 in. high, and 5 ft. wide, the cars having decks 5 ft. x 5 ft. 3 in. In this kiln the heating-up, burning and cooling zones are of equal length, but the cooling zone is built almost entirely of sheet steel sections of very much the same type of design as the Proctor dryer. Water cooling pipes have been installed for almost the entire length of the cooling zone to expedite the cooling ware. The cars are moved by means of a chain drag.

Russel (Zwermann) Kiln
Kalamazoo Sanitary Mfg. Co. This company is operating two kilns which were the original ones built under the direction of Zwermann. They are of the single funnel type and not the twin-type which he subsequently developed. These kilns are 360 ft.

long, although they were originally shorter. One of them is burning closets and tanks to cone 10 and the other is glazing the bisque bodies at cone 6.

The tunnels are 7 ft. 6 in. high to spring of arch, the arches having a 15 in. rise. The kilns are 76 in. wide. The cars are 7 ft. 6 in. long, 5 ft. 9 in. wide and $2^1/_2$ ft. high to top of deck. They weigh $6^1/_2$ tons when loaded and are 32″ gauge. On account of their great weight, winches are required to move the cars about the plant. It is estimated that these cars would hold 3,000 9-in. fire brick.

Each tunnel holds 48 cars, which move at the rate of a car length in $1^3/_4$ hours in the bisque kiln, and 2 hours in the glost kiln.

Each kiln is equipped with five oil burne s, which are staggered three on one side and two on the other. Tate-Jones and Stakleen burners are used with an air pressure of thirty pounds and an oil pressure of twenty pounds per square inch. The high fire zone is in the exact middle of the kilns.

The kilns are equipped with sand-seals and the bottoms of the cars are air cooled. They are equipped with fan-draft and the temperature of the exit gases at the cooling end are approximately 130°F. The temperature of the ware coming from the kiln is approximately 350°F. Although the ware burned has a thoroughly vitreous porcelain body, it is not damaged by this exit temperature.

Cooling is expedited in this kiln through the use of false walls and crown, the cooling end being a double tunnel. Air is drawn through this space by means of a fan and distributed through heating pipes to the dryers and various parts of the building for heating and drying purposes. The temperature of this air is about 250°F. These kilns are equipped with two small auxiliary chimneys about 8 in. in diameter which extend through the crown in the high heat zone. Each is provided with a damper. The function of these stacks is to make it possible to draw any reducing gases which may form eddies in the burning zone. They serve to keep the kiln atmosphere thoroughly oxidizing.

The up-keep on these kilns has been remarkably low. They have been operating for five years and during that time have been shut down but three times, one of these occasions being when the factory burned down. Neither of them have been shut down during the past three and a half years and at the present time are in perfect condition. There has been absolutely no repairs to the refractory linings since they were originally constructed. The high heat zones are lined with a Missouri fire brick which has a fusion point of cone 32–33.

One of the points worth noting in the operation of these kilns is that the ware, which is placed in saggers, is set on each end of the car with an open

space in the middle extending from top to bottom. The length of the cars is such that this open space is directly opposite the oil burners, the space therefore being really a combustion chamber. It was found necessary to leave this space in order to prevent the oil from being impinged on the saggers, it being found that if allowed to do so, a sort of rotting effect took place. This effect, however, would only be encountered where oil fuel was used.

The variation in temperature from top to bottom of these kilns is less than one-half cone, there being no variation from side to side.

The loss in the bisque kiln is about 2½% as against 8 in the periodic and 2% in the glost kiln as against 8 in the periodic. Again in this case, there has been no particular fuel saving due to the fact that fuel oil was substituted for coal.

Farber Kiln
Farber Fire Brick Co.

The kiln at this plant was designed by themselves, being patterned after the Didier-March kilns at Keasbey. No exact construction details will be given as it was requested that this be not done. The kiln is approximately 250 ft. long and the cars contain from 2,000 to 2,500 9-in. brick. The product is entirely dry-pressed, the semiflint fire clay of the Mexico district being used. The ware is taken directly from the presses and set on the kiln cars. The cars are then taken into a drying room, where most of the moisture is driven off; they are then placed directly in the kiln. This kiln produces from 10,000 to 14,000 9-in. brick per day and is operated by producer gas.

The brick are burned under oxidizing conditions and come from the kiln almost a paper white. The clay used contains nodular pyrites, some nodules being quite large, but under the burning conditions these do not ordinarily make bad iron spots.

In this kiln were embodied a number of original ideas which have not worked out as successfully as was hoped for but in spite of this fact the results have been satisfactory to the operators. The product coming from this kiln is practically 100% salable and is an active competitor with other brands of equal grade in the Mexico district. The product is shipped as far east as Cleveland and Detroit, where it comes into active competition with Kentucky and Pennsylvania brands.

It was noted that the bottom brick were often kiln marked or cracked, due to the superimposed weight which is to be expected where a dry-press product is set direct from the press to a car which gets considerable moving before reaching the burning zone.

The operation of this kiln, especially under these conditions, proves beyond a doubt the feasibility of burning the clays of the Missouri district successfully in this type of kiln.

Harrop Kiln
Mt. Clemens Pottery Co.

At this plant are two Harrop kilns, one bisque and one glost. The bisque kiln will be described.

This kiln is 323 ft. long and 4 ft. $6^1/_2$ in. wide and is operated on a $1^1/_2$ hour schedule to cone 10. It was erected about eight months ago and has been operating continuously except for one shut-down caused by labor trouble.

The ware produced is table china. While this kiln is at the present time operating on a $1^1/_2$ hour schedule, it has been shown capable of a much greater capacity and has given satisfactory results on a fifty-five minute schedule.

The kiln is fired by means of six coal-furnaces which are located three on each side of the center in a staggered position. The furnaces are equipped with stokers and preheated air is supplied for primary and secondary combustion. This air is blown through channels in the walls and crown of the cooling zone by means of a fan and is fed to the fire boxes at about 400°F.

The combustion gases are exhausted at 400°F and the ware is taken out at a temperature of 650°F. At the present time a fan is being installed for the purpose of reducing the temperatures of the exhaust gases and the ware at the exit.

Cars used are single gray iron castings with a gridded top and having two double-flanged wheels on one side and two flat faced wheels on the other. This arrangement takes care of any expansion or contraction in the track gauge.

The kiln holds 48 cars and the cars are moved by means of a hydraulic ram which carries its oil for actuating in its own base.

The kiln has a sand-seal and the cars are effectually air-cooled as is shown by the fact that they are easily pushed by one man and are lubricated with 600 W oil.

This kiln, which, as stated before, is operating at cone 10, is lined through out the hot zone with dry-pressed Missouri fire brick which, up to date are apparently standing up perfectly.

This kiln offers a splendid opportunity to judge as to fuel saving. The company formerly operated down-draft pottery kilns, coal fired. With its present installation, also using coal, they show a fuel saving ranging from 75 to 85%. They have had no kiln repairs to date and feel certain there will practically be none; they claim no labor saving although it is self evident that there must be some.

This kiln cost $60,000 and was built in 1920 at the time of peak prices. It is estimated that it could be duplicated today for $50,000.

Didier-March Kiln
Didier-March Company

This kiln was built in 1910 and has been in almost continuous operation since that time. It is 197 ft. long with the high heat zone somewhat nearer the coiling end

than the heating-up end. It has been used entirely for the burning of refractories.

The kiln holds 36 cars which are operated by a chain drag at the entering end. Each car holds from 920 to 1,000 9-in. brick. The kiln is operated ordinarily on a 2-hour schedule at from cone 10 to 14 and has a capacity of approximately 14,000 9-in. equivalent per day. Each car remains in the kiln from 60 to 72 hours.

The kiln is equipped with a sand-seal and the cars are air-cooled.

The kiln is fired with Youghiogheny coal, the average fuel consumption being from 650 pounds to 700 pounds per thousand 9-in. brick, which represents a saving of over 60%, based on the consumption of the round down-draft at the same plant. Taking into consideration setting, burning and emptying charges, the saving is in excess of 50%.

The temperature of the combustion gases at the exit is approximately 300°F. This could undoubtedly be reduced were the kiln not so short.

Primary air for combustion is delivered to the fire boxes in a preheated condition, this air being drawn through the cooling ware.

The breakage in this kiln has averaged less than 1%. The up-keep has been extremely small, the main parts of the lining being part of the original installation. This lining was of high grade fire brick, presumably of New Jersey manufacture.

As the operation of this kiln was dealt with in detail by Mr. Raymond M. Howe in his report[1] of September 19, 1917, it is considered unnecessary to go into further detail.

Part III

Tests on Firebrick

The Committee came to the conclusion that, as Mr. Howe had spent so much time in making physical tests on various brands of fire-clay brick for the purpose of the report above referred to, it would be unnecessary and merely a repetition to make further tests of the same character. It must be borne in mind that Mr. Howe's tests were made on a kiln that is shorter by at least 100 ft. than would be recommended for the burning of refractories by any present day tunnel kiln engineer. It must also be remembered that any tests carried on would have to be made under the conditions prevailing in the kiln selected and that while these conditions might be correct for one or half a dozen clays, they could hardly be correct for all the clays selected for a test.

In order to make this report more complete, the findings of Mr. Howe's investigation are included herewith.

[1] Howe, *Special Report*, Refactories Manufacturers Association's Industrial Fellowship. No. 1. "A Study of the Tunnel Kiln and Its Application to the Burning of Refractories."

Discussion of Physical Tests

I. These brick were made by the stiff mud process using an auger machine, and were steam repressed. New Jersey fire clay, grog and ganister were used in the batch. The ware burned in the tunnel kiln showed the same physical properties as the ware from the intermittent kilns. The slight difference observed was more likely due to experimental error rather than conditions of burning.

II. These brick were made by the soft mud process from 15 per cent bond clay and 85 per cent flint clay, part of which had been calcined. The clays were from the Cambria district. The ware coming from the tunnel showed greater shrinkage, greater strength, and lower porosity, all of which indicated that the tunnel kiln burn was more thorough.

III. These brick were much the same as those of type B—being higher in flint clay. The ware from the two types of kilns was essentially the same.

IV. These brick were from the Southern Ohio district. The two burns showed practically the same quality of ware.

V. These brick contained twenty per cent bond clay and eighty per cent flint clay, part of which was one-half an inch in diameter. These large particles of flint clay often protruded from the sides of the fire brick as they came from the tunnel kiln. A great many surface checks were found in the brick coming from the tunnel kiln. The brick were also weaker than those from the regular burn, showing that the surface cracks evidently extended throughout the brick.

VI. These brick contained ninety per cent flint clay and ten per cent bond clay. They showed that they had received a harder burn in the tunnel kiln than in the intermittent kiln.

VII. These brick were from the Pennsylvania-Ohio district and were made by the soft mud process, twenty-five per cent bond clay and seventy-five per cent flint clay. The brick were discolored and cracked as they came from the tunnel kiln, showing a large amount of iron both on the surface of and throughout the brick. The ware from the intermittent kiln showed some traces of iron but it was not discolored as was the ware from the tunnel kiln.

VIII. These brick were made with an auger machine from the same batch as given in VII. The stock brick were nearly white, dense and very strong. The ware coming from the tunnel kiln was spotted and slightly weaker.

General Conclusions

I. Fire brick made from calcined clay grog and bond clay may be successfully fired in the tunnel kiln. The quality of the ware coming from the tunnel kiln is of a quality equal to that coming from the periodic kiln.

II. Fire brick made from flint clay and bond clay may besuc cessfully fired in the tunnel kiln. The flint clay, however, should not be introduced in too large particles if the ware is to be burned and cooled in seventy-two hours. If some of the flint clay has been previously calcined very good results are secured.

III. When the bond clay becomes dense at a low temperature, difficulties are liable to arise when such a clay is burned in the tunnel kiln. Bricks of types seven and eight show this. It is believed that such brick, those which become very dense, should be fired to a lower temperature, or else be fired in a longer tunnel kiln. Either one of these procedures, if followed, would result in the lessening of the severity of the heat treatment.

IV. Iron, if present, results in the formation of dark spots on the surface of the brick coming from the tunnel kiln. If an excess of air is present, such as is found in the periodic kiln, it oxidizes the iron and its color is less pronounced. This excess of air lowers the efficiency of the kiln. As a result, if the high efficiency of the tunnel kiln is to be retained, such iron spots are unavoidable.

V. Brick were also sent through the tunnel kiln which were made by the dry-press method. They were packed in such a way that the original moisture content was present when the bricks were introduced into the kilns. The results were not satisfactory for two reasons. The brick are ordinarily burned to cone 10; here they were burned to cone 14 and in a very short time. As a result cracks were developed. Were the kiln longer the brick would not have been subjected to such a strain during the water smoking period. It is believed that by using a longer kiln that dry-pressed bricks can be set directly on the tunnel kiln car and be burned successfully.

VI. By using a kiln of suitable length, properly proportioning the raw materials, properly sizing the raw materials, and burning to a proper temperature there appears to be no reason why all refractory fire clay brick can not be successfully burned in the tunnel kiln.

Recommendation

The Committee has decided not to make any recommendations or to arrive at any conclusions in this preliminary report. It is intending to visit two other plants and to conduct burning tests on silica refractories. It is hoped that all the information necessary to make the final report will be in hand before the Annual Meeting of the Association in March, 1922.

S. M. KIER, *Chairman*,
A. F. GREAVES-WALKER

OBSERVATIONS OF FISHSCALING OF GROUND COAT ENAMELS[1]

By B. T. Sweely

The subject of fishscale is an old one with enamelers and always a live one, for like other evils of this vale of tears, it is always with us. The theories advanced as to its cause, and the remedies and solutions put forth for its prevention, are as numerous as the men engaged in the industry. As each of us has at least two or three pet theories he will gladly expound on the slightest provocation. It was not until recently, however, that accurate data on the physical properties of enamel and steel were presented and their relation to the development of fishscale shown.

Danielson and Souder[2] have shown very nicely that the phenomena of fishscale is intimately connected with compressive stress in the enamel. While many factors are undoubtedly operative in addition to differences in coefficient of expansion of the steel and enamel, the conclusion reached by these investigators is that the fundamental cause is due to compressive stress, and that the ideal solution would be an enamel in which this stress was very low or entirely absent. Such a result is to be attained by compounding an enamel whose coefficient would be equal to that of steel, or so alleviate the stress in the average enamel that failure in the characteristic fishscale form would not occur.

During one of the spasmodic occurrences of fishscale in our plant, the writer sought to test the validity of this idea by removing the enamel from one side only of a piece of ware on the assumption that, if the enamel was in compression, the removal of it from one side of the steel should throw the entire stress, formerly taken by the inner and outer coats, upon one coat and result in an exaggerated case of fishscale over the area from which the one coat of enamel was removed. This was accomplished by placing two or three hundred cc. of concentrated HCl in a basin and allowing it to stand over night, which completely dissolved the first coat on the inside of the basin.

On the trial so treated, the area of first coat removed on the inside is very sharply defined by the fishscaled area on the outside of the piece. While there is some evidence of fishscale at other points on both inside and outside of the basin, over the area defined by the dissolved inside first coat a very pronounced case of fishscale has developed.

In order to find if this result was in any way due to hydrogen penetration of the steel after the first coat was dissolved, and also whether a piece ground coated on one side only would develop the same result, a basin was coated on the outside only with the same enamel and the same acid test made as before. No fishscale developed over the area subjected to the acid treatment, nor is the piece at any point decidedly fishscaled.

[1] Enamels Division, St. Louis Meeting, Feb. 28, 1922.

[2] Danielson and Souder, *Jour. Amer. Ceram. Soc.*, **4**, 620 (1921).

The next was an endeavor to produce a ground coat whose coefficient of expansion was high enough to practically eliminate compressive stress in the enamel, and subject such a piece to the same acid test. The enamel was based on the conclusions reached by Danielson and Souder, and had the following theoretical composition—

	Melted %
Feldspar	55.0
B_2O_3	5.0
Kryolith	12.0
Na_2O	10.0
CaF_2	7.5
BaO	10.0
CoO	0.5

The theoretical cubical coefficient of this enamel according to the factors given by Mayer and Hovas[1] is 432×10^{-7}. The figure given by Danielson and Souder for average steel is about 384×10^{-7}. Considering these factors, it is obvious that if both were absolutely true, this enamel should be in tension rather than compression, and if the difference is sufficiently great the enamel should craze rather than fishscale.

Samples were coated with this enamel and treated with acid as before. There was no evidence of fishscale shown at any point on the piece; the removal of the enamel from the inside of the basin having resulted in no sharply defined area of fishscale, as was shown on Sample 1. Further when applied in a rather heavy coat, and with the light falling at just the right angle, craze lines can be faintly seen, indicating that the assumptions made in compounding the enamel were at least partly correct.

The above data would seem to indicate that the solution of the fishscale problem was well within reach, all that is necessary being to make up an enamel whose theoretical coefficient is well above that of steel, and forget our past experience with fishscale and all its puzzling losses. Actually, however, the commercial use of an enamel of the above type is practically impossible. The very high content of fluxes of this enamel makes its heat range very short, and its use in the average plant is not feasible. Continued experiments along these lines by the writer have seemed to indicate that under our factory conditions any composition whose theoretical coefficient amounts to approximately 400×10^{-7} will not fishscale. With this fact as a ground work, an interesting field for investigation is thrown open.

We have not as yet reached a point in our experimental work that would lead us to believe that a panacea for all fishscale is within our grasp, but it does seem obvious that we can at least reduce the tendency for this defect to develop under any given set of conditions.

[1] Mayer and Hovas, "Coefficient of Expansion of Enamels and Their Composition," *Sprechsaal*, **44**, 188 (1911).

An interesting development of the above experimental work was the application of this test to ground coated ware on which various compositions had been fired to different degrees of maturity. It was found in nearly every case that the harder a piece was burned, the greater the tendency to fishscale for any given enamel and, in all but a few cases, very little fishscale would occur under the test on a piece that was decidedly underburned.

A point in connection with the data herewith which I believe should be emphasized is that too much dependence can not be placed on the theoretical values arrived at in calculating the coefficient of expansion of an enamel from the tables of Mayer and Hovas or Wenkleman and Schott. It has been the writer's experience that of two enamels whose coefficients may be exactly the same theoretically, one may fishscale and the other will not. If our assumption is true that compressive stress is the cause of this phenomena, then it must be that the degree of volatilization of those fluxes supposed to impart a high coefficient of expansion to an enamel must play an important part. For this reason the intensity of the smelting treatment, the content of easily volatilized fluxes, etc., will all be operative, and it does not seem possible to lay down a hard and fast rule that will hold under all conditions.

These variables may account in part for the often cited case of a ground coat enamel working satisfactorily in one plant and failing completely in another. It is my opinion that we are nearing a solution of this troublesome question in which the work of the Bureau of Standards is to play no small part, in that we have at last a definite cause assigned for the trouble, *i. e.*, compressive stress. Should future developments prove that we are not mistaken in the above conclusions on the occurrence of fishscale we will need only look over our factory practice to determine why the compressive stress in our enamel is greater than at some time when our ware was free from this defect and correct the trouble at its source.

While this seems a simple and obvious remedy, there is little doubt but that much long and tedious experimental work is still before us, and that the ultimate solution will be a matter of long continued research and development.

CERAMIC LABORATORIES
COONLEY MANUFACTURING CO.
CICERO, ILL.

Discussion

MR. WIESTER:—I would like to ask if Mr. Sweely means that overburned ground tends to fishscale more than underburned ground.

MR. SWEELY:—That has been my experience.

MR. WIESTER:—On any kitchen product such as a teakettle the enamel on the bottom is always a little heavier and a little bit underburned, and that is where most fishscaling comes.

MR. SWEELY:—I think that that goes back to the question of Mr. Danielson's investigation on the spinning, the working of the steel. That is true. A piece of steel that has not been spun or worked will fishscale worse than over the area that has been worked. The bottom is usually not worked, spun or stretched in the forming operation; it is the sides that get worked.

Mr. Geisinger's observations do not check with my experiments. A basin coated with the same enamel as used in the acid test described but applied only to the outside, and subjected to the same acid treatment as was used on the fishscaled samples showed no fishscaling. I have checked this a number of times with different compositions but have never had a sample develop fishscale under this test.

BY E. E. GEISINGER:—It appears that the following experiment would rather upset Mr. Sweely's suggested explanation that the fishscaling was caused by the releasing of a strain in the enameled ware. Our ware is enameled on one side only, which accounts for our method of attack.

About three years ago, our enameling superintendent suggested that the laboratory staff try the following experiment and if possible give the reasons for the results. Small test dishes, measuring 6″ in diameter and pressed from $^1/_4$″ thick steel, were enameled upon the inside only. They were then placed in approximately 20% solutions of nitric, hydrochloric and sulphuric acids, respectively. After allowing the steel dishes to be attacked by the acid for about 8 hours, we were very much surprised to see that the enamel was fishscaling upon nearly all the cups. Very little of the steel had actually been eaten away, and we could not explain the reasons for the fishscaling. Mr. Treischel at General Electric Co. has suggested hydrogen penetration as a course for chipping, and it is possible that this is the cause but the proof is not well based.

BY R. R. DANIELSON:[1]—It would seem that the relative expansion of the steel and enamels was a factor in the ability of the enamels to adhere when the vessel was treated with acid, inasmuch as the enamel compounded to have a higher coefficient of expansion than the steel did not develop fishscaling when treated with acid. While the hydrogen penetration, as pointed out by Mr. Geisinger, might tend to loosen the enamel, undoubtedly the hydrogen penetration in the tests which Mr. Sweely made would be as great with one type of enamel as another, and it is to be recalled that only the enamels having a low coefficient developed the defects upon treatment with acid.

R. R. DANIELSON:[2]—The coefficient of expansion of the enamel referred

[1] Received May 22, 1922.
[2] Received June 29, 1922.

to in Mr. Sweely's paper has been determined by Mr. Souder of the Bureau of Standards. The frit as used by Mr. Sweely was ground with 7 per cent of Johnson-Porter clay and 1.5 per cent of borax. The determination was made on the milled enamel with the following results for linear contraction:

Temperature range	Average coefficient of contraction
400° to 200°C	14.2×10^{-6}
200° to 20°C	12.7×10^{-6}

It is interesting to note that the values given by Mayer and Havos and used by Mr. Sweely in computing the coefficient of expansion were based on determinations from 0 to 100°C, and that the computed value is approximately the same as that for the actual values determined by Souder in the range 20° and 400°C. The Bureau's value in the range 20° to 200°C would be low as compared with that computed from the values from Mayer and Havos.

PRESSING TERRA COTTA

By John Clark

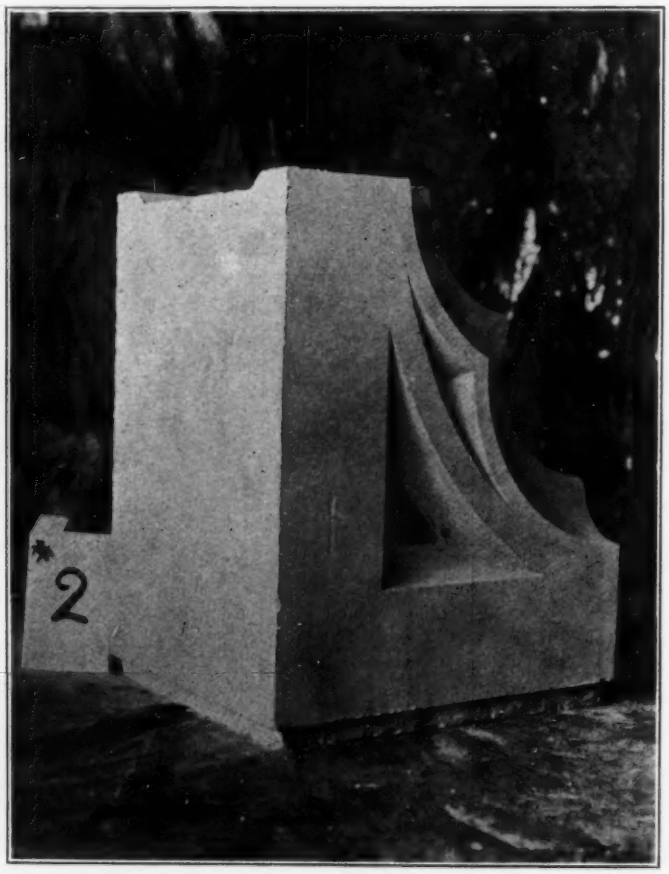
It is my belief that the question of proper pressing of terra cotta should have careful consideration. Failures of terra cotta at the building are more often due to some fault in pressing than to any other cause.

The American Ceramic Society and individual manufacturers have studied the problems of bodies and glazes with resulting great improvements. The work which has not received the study and attention it requires is the pressing. I might also include finishing, but this to my mind is not so important as the pressing.

The preparation of bodies and glazes being well done, it is equally important that the pressing should be well done if the piece is to stand the

strain that is to be put upon it when placed in the building. Given a body of the right proportions of clays and grog, and properly tempered by thorough pugging, it is then for the presser to make the piece, and this is where improvement must be made.

After a piece of work is turned out of the mold it should show no seams either on face or sides, and the struts or partitions should be so well worked

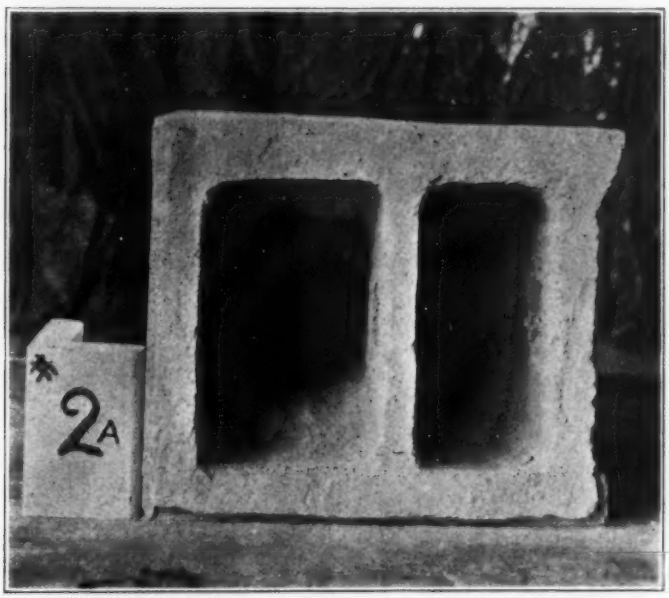


and welded into the sides that to all intents and purposes it is one piece of clay. In many cases when a piece is turned out of the mold, instead of one piece of clay there are five, the sides, ends, face, and as many more as there are struts in the piece.

To get a good press the clay must be pressed: Pressure must be applied to the clay after it has been put into the mold, and all of the vertical and horizontal corners welded together. The presser, after the face is in place,

generally puts in the ends next, and brings it up to the required thickness. This is not the way to produce the strongest piece of work. The sides should be put in first and the ends last, so that there is a greater opportunity to wedge the ends to the sides.

Too many pressers in working up the face bring up some of the clay to a distance on the sides of the mold until it is as thin as paper. This is a bad practice for if the molds are at all dry this thin clay dries out very rapidly, and when the upper layer is put upon it proper adhesion between the two can not be had. This shows after burning by this thin layer having shrunk away. The point of a knife inserted between the two surfaces will

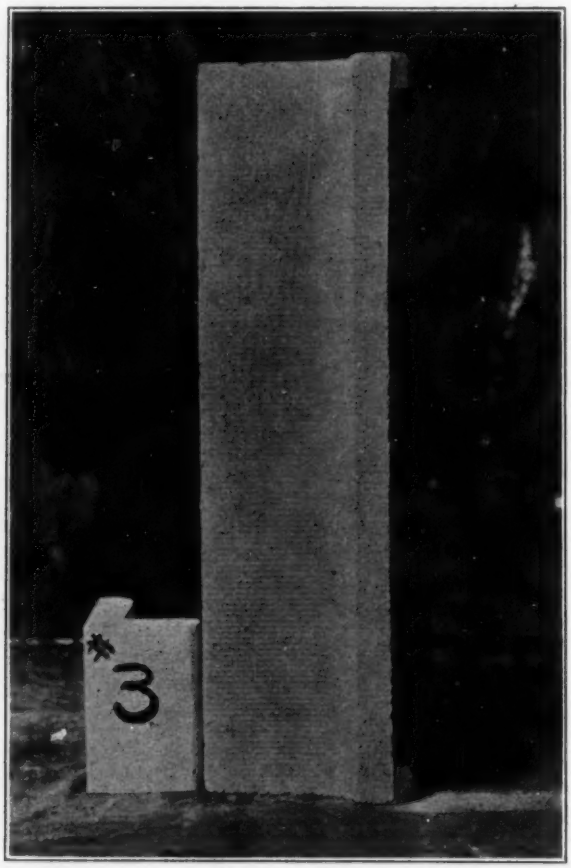


cause this layer to split off readily. The same thing would result from freezing.

Too many pressers do not understand the nature of clay. Because it is a soft sticky material they expect it will easily bond together and that placement in the mold is merely to give it shape. There is a common notion also that it is only necessary to press the face well, doing the rest of the piece in the easiest and quickest way possible.

Care Required in Drying.—After the piece has been pressed, care should be taken that it does not stay too long in the mold before being turned out on to the board, especially when there are projecting parts on the face or sides, such as dentils, slots for steel forms, and in large

cornice sections where the washes, instead of having an angle back to the bond, have a curve. All of the projecting parts on the interior of the mold begin to act as a wedge as soon as the clay is placed between them, by reason of the shrinkage of the clay. Those pieces having a curved wash in many cases develop an incipient crack owing to the greater projection pulling away from the bond while in the mold, which upon turning out



on to the board is invisible and does not show until the piece is thoroughly dry, and in some instances not until it comes from the kiln. If such a piece of terra cotta is put into a building these projecting parts, especially ornaments, will shelve off due to lack of sufficient bond to withstand the disrupting action of freezing water.

Finishing of Terra Cotta.—A well-pressed piece needs very little finishing, especially where it is tooled. Smooth ashlar work may be made

out of shape by the movement of the clay structure, while the finisher is working upon it. The filling up of seams is a subterfuge, because the clay is only rubbed over the surface and smoothed with the scraper. The piece can, in many cases, be pulled apart showing the seam almost through to the interior. These seams may go through the various stages of manufacture, and after the pieces have been placed in the building, they may open up by the expansion and contraction due to heat and cold.

Pressing can never be done too well. A well-pressed and thoroughly burned piece, in which the sprays, glaze and body are of the right coefficients of expansion and properly cooled, should stand all that is required of it when set in the building.

Illustrations of good and bad practices: The photographs of pressed or burned pieces submitted herewith illustrate some of these points.

Photograph No. 1 shows a piece which has been well-pressed. It required very little finishing. Had this not been well-pressed the presser would have had to go over the various members with finishing tools. In nine out of ten cases he would not have improved the lines, but on the contrary they would have been more or less awry.

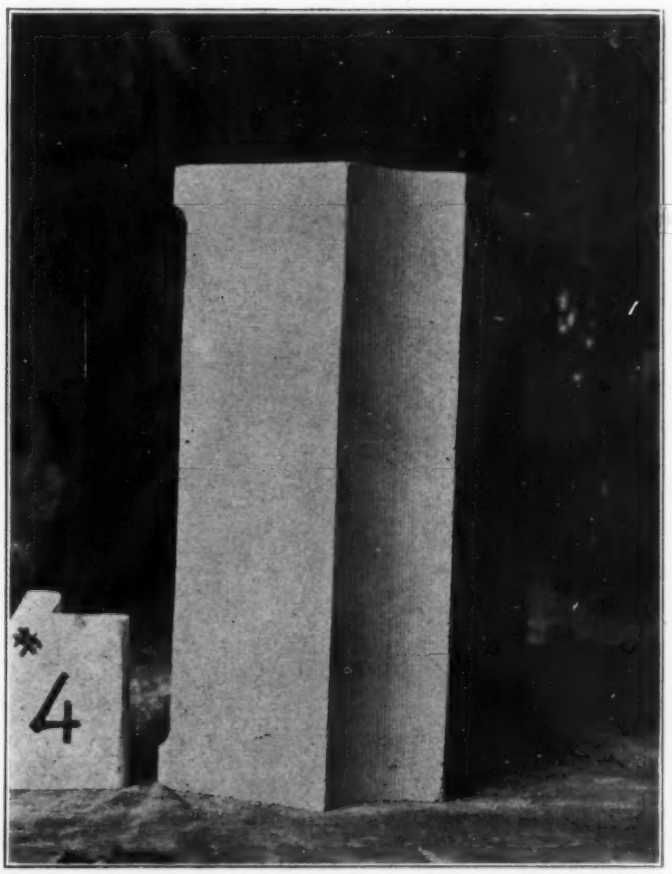
Photograph No. 2 shows a piece that has been well-pressed, with no finishing. This piece although rather complicated is as well bonded as if it were one piece of clay.

Photograph No. 2-A shows the interior of the piece. There is an entire absence of cracks between the ends and sides, and between the struts and the sides.

Photographs No. 3 and 3-A show a piece which is not so badly pressed on its face, but the back or wash of the sill is faulty, due to bringing the

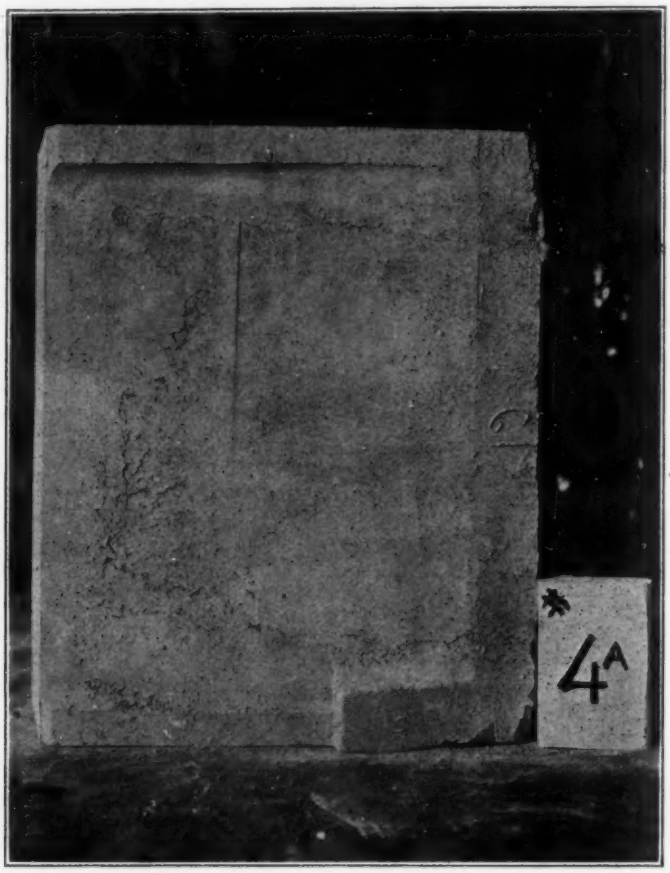
clay up the sides of the mold until it is as thin as paper. Pieces like this can be pulled apart and one can trace the dividing line right through into the interior of the piece. Many cases of shelving of the face of the work at the building from freezing may be directly due to this cause.

Photograph No. 5 is very similar to photographs 3 and 3-A except that the piece has been burned. Note how it has slivered at all the arrow



points, and at points "A" the corner has fallen off completely. Pieces of the type represented by 3, 3-A and 5 are very dangerous ones in a building. Unless these seams are crammed and the clay well worked into them the water will find its way into these seams and with alternate freezing and thawing, they will be gradually forced apart. As pieces of this type, (sills, washes of cornice, etc.), have a large area exposed to the weather, it is of the utmost importance that they be a well-pressed piece of clay over their entire surfaces.

The face is a fine piece of pressing, but the back (No. 4-A) has not been properly pressed. Photograph No. 4-B shows that it is cracked at each end, and also that the strut has parted from the side. While this piece has been taken in a vertical position its position in the building is a horizontal one. With the cracks at the two corners and in strut it is quite conceivable that when the weight of the wall is brought to bear upon it,

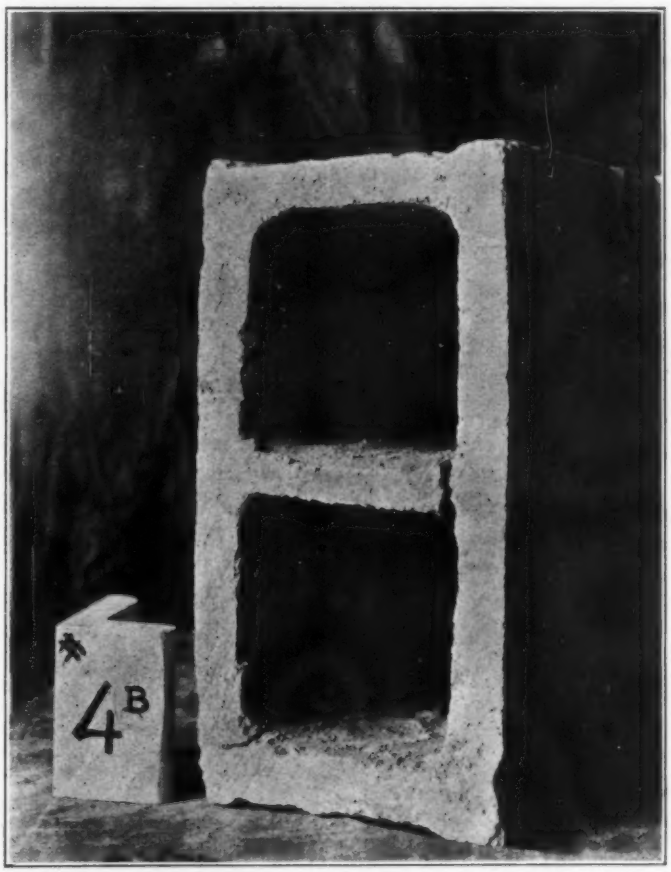


it will give way. This illustrates that the long sides in pieces of this character should be pressed first and the ends last. There is less tendency to crack when made this way, and even if it should crack it is not so serious as when the crack is vertical or nearly so.

These observations have been chiefly made in two plants, and among pressers who have worked in the various plants of the country. From my experience with pressers the tendency to poor work is on the increase

and it is therefore very important that all companies coöperate in training men who will really press work and not produce tonnage only.

There is no process in a terra cotta plant that needs more careful watching than the pressing. The piece produced by the presser is almost the end; all processes previous to pressing are means. The processes after pressing have been well studied and standardized but the pressing has



not received the attention it should. It is of the greatest importance that the pressing be well done if terra cotta is to hold its reputation of being good building material.

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GOOD AND BAD PRACTICE IN THE PRESSING DEPARTMENT

By T. A. Klinefelter and F. C. Parsons

Introduction

One of the vitally essential departments in a terra cotta plant is the pressing shop. Here the terra cotta is actually made, and receives its initial handling. Every shop has developed both good and bad practices, all its own, and methods of handling minor details peculiar to its peculiar condition. There are, however, a good many things of general interest to all terra cotta manufacturers, which may be discussed profitably.

So far as the shop itself is concerned, floor area of the right sort, good light, and proper methods of delivering clay, and taking the ware away, are the main concern. It goes without saying that poor, uneven floors, dim light, and antiquated methods of handling are costly in time, money and quality in any department. It is assumed that this is taken for granted.

Terra cotta is hand pressed. Practically all terra cotta now made is pressed by hand, and not by machine. Various schemes have been devised from time to time to make terra cotta by machine, but so far with little or no success except, perhaps, in small simple designs. Owing to the great diversity of shapes, hand pressing is likely to continue in vogue for some time and even if machines are developed for handling plain shapes such as ashlar, it is hard to see how we can get away from hand pressing on a commercial scale.

As is usual in all hand made work, eternal vigilance is the price of high quality. It is purposed here to point out a few of the things which may happen when the work is done in the wrong manner.

Correct Methods of Pressing

While pressing looks like a rough, crude piece of work, there is a right and a wrong way to do it. In general, what we want is a uniformly thick continuous wall, including face, sides, edges and partitions. We want no laps, no blebs, no lines or planes due to imperfect welding. Experience has shown that the best commercial way to do this is to throw in a good sized roll and pound with the whole hand or fist, using the thumb just as little as possible. If the thumb is used, invariably the clay is not slugged hard enough and wherever the thumb has run along, an imperfect weld and air blebs result.

Method of Building Up Sides.—It is fairly easy to get a good even layer for the face at the bottom of the mold, but unless care is exercised, a continuous run up the sides is not obtained. This is the case where the face is filled flat and the side set in. There is no chance to push and work the sides against the face, hence the imperfect welds. A good sized roll

should be pounded in all around, at a greater height than the thickness of the face, being wiped off against the side gradually. Then, when the side goes in, it has a line of clay to push and bite against and is more likely to make a perfect weld.

FIG. 1.—Correct pressing along edge. Roll of clay slugged with fist.

FIG. 2.—Correct pressing in corner.

The corners should be filled in exactly the same way; a roll pounded in with the fist and *not* with the thumb.

Method of Building Partitions.—Partitions are an important part of a piece of terra cotta and may be set in in such a way as to thoroughly bond

in with the face and sides, or they may be merely inserted. In some English terra cotta it has been the practice to dust the edges of the partition before setting in so as to prevent it becoming an integral part of the piece. The idea is, presumably, that since the partitions are merely rolled

FIG. 3.—Incorrect pressing along edge, "Thumbing." Shows formation of pockets which result in blebs or open spaces.

FIG. 4.—Incorrect pressing in corner. "Thumbing."

and flattened and not pounded to the same degree as are the sides and face they will shrink more and hence tend to draw the face and sides in if bonded too tightly. However, the advantages of having the partitions well bonded in outweigh these shrinkage difficulites, hence it is a better practice to make as good a weld as possible.

The proper way to place partitions is to scoop out a good broad, fairly deep channel in the sides, lay the partition in, then lay a roll of clay in each corner and work this roll into the body and partition at one and the same time. The scooping out of the broad trench not only inserts the

FIG. 5.—Correct. Face is "wiped" up against side in order to give material enough for the side to bond in properly.

partitions in the side, but takes away so much clay that the presser is forced to use a roll.

Method of Preventing Warping.—In order to hold the pieces to the right shape it is often necessary to make use of a shoe in the pressing. This

FIG. 6.—Correct. Same as Fig. 5, except showing a side partially worked in. Note that no line of union shows, indicating a strong continuous body of material.

is merely a flange or ring, fitting down on the mold and projecting over the inside a couple of inches all around. The presser works the clay up against this flange from beneath so as to form a sort of inward lip all around, which stiffens the piece decidedly and counteracts tendency to warp.

The same thing is accomplished by "flushing over" which is merely a free hand way of doing the same thing, the plaster shoe being omitted. While the shoe might be omitted, since the same thing can be accomplished by flushing, it insures that this extra pressing will really be done without the necessity of constant inspection by the foreman.

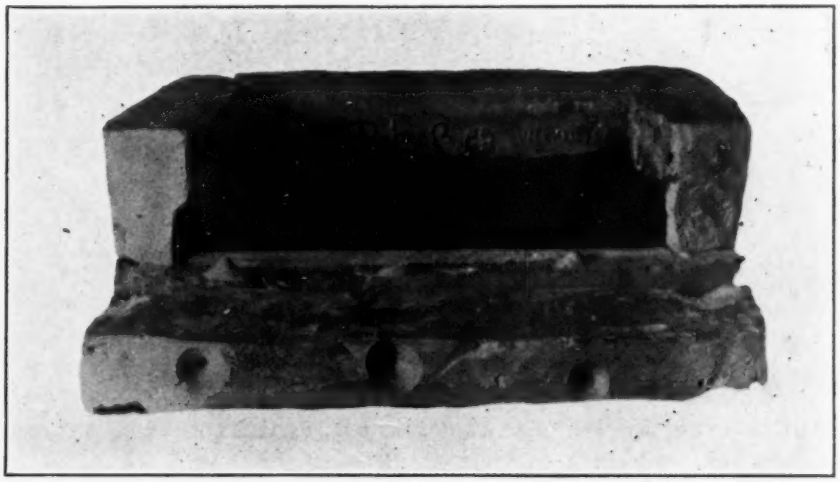


FIG. 7—Incorrect. Face is not "wiped up against sides."

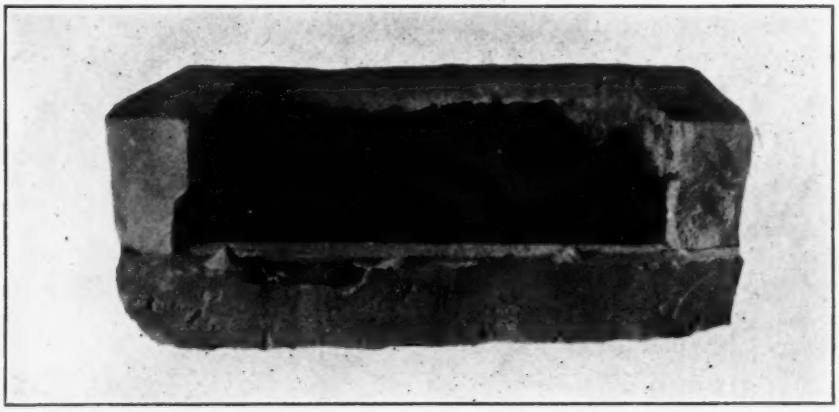


FIG. 8.—Incorrect. Same as FIG. 7, except showing a side set in place. Note the strong line showing at junction of face and side. Piece will be weak along this line.

Sill pieces, which carry a groove for a water bar, is an example of where this extra pressing is of value. The partition through the center tends to draw the surface down at the back where the groove runs, and results in a hollowed surface, so that while the water bar may fit snugly at the two ends

it may be almost clear at the center. To counteract the draw of the partition, the flushed over edge is pressed in. This gives a sort of truss, acting at right angles to the draw of the partition and holds the piece straight.

Molding of Projecting Parts.—If there are any projections from the mold into the clay, the clay will hang on these projections and cause cracks to develop. Pieces, such as dentil should not remain in the mold over night.

FIG. 9.—Split side mold. Upper right hand corner shows projection for making water bar slot. Note the split in the mold 2 or 3 inches below the projection.

In case a projecting piece shows cracking, one might just as well pull it off, dowel and stick it back on, for otherwise the frost will split it off. No doubt some terra cotta has gone to pieces in past years due to this.

In case the projection extends clear across a mold, as in large sills with a water bar, it is often good practice to split the side of the mold. The

one piece containing the projection can be removed a few minutes after pressing and the piece then can shrink all it will without the slightest "hanging."

Method of Turning to Obtain Uniform Drying.—After standing in the mold a sufficient length of time, a board is slipped over the top and the whole thing, mold and piece, turned clear over. This is much more important than a great many people think, especially with pieces of such size that the weight of their walls is sufficient to cause sagging. The aim should be to always turn the mold so that the finished surfaces revolve in a vertical plane, or if horizontal, have the mold to support them. Ashlar mitres are especially mean to handle in this manner, and may be completely spoiled at this stage by improper turning.

FIG. 10.—Same as Fig. 9, front view. Shows the split part removed and placed above for better inspection. A small portion is shown pressed.

Finishing of Terra Cotta.—After turning out of the mold, the next step is finishing. Generally speaking, the less finishing the better. There are two general methods. The water brush method, and the ordinary with steel and wooden tools.

The water brush method consists of finishing the seams by tool and then going over the surface with a brush full of water. This method has already been described by Hewitt Wilson.[1] It is in use in some places. It is hard, however, to get the pressers to do water brush finishing properly. In order to finish by the water brush properly, the pieces should be finished the same day they are pressed, otherwise the surface may water check. Another bad feature is that the ornament tends to be unduly dulled, and it is generally dull enough as it is.

[1] *Jour. Amer. Ceram. Soc.*, **3**, 114 (1920).

The usual method is to smooth off the surfaces with steel pallates or scrapers. The danger here is largely in finishing too soft or too hard. Too soft gives a wavy surface. Too hard gives a surface on which the slip or glaze does not adhere properly because the surface becomes compacted and does not present the usual open porous condition to which the weight of the glaze has been adjusted. It is almost like trying to spray a hard biscuited piece. Since the slip is adjusted for a fairly porous surface, such a compact surface is likely to result in separation and peeling back of the slip during the burning. Cases have been noted where this condition was so bad that the slip would not stick even in the green state.

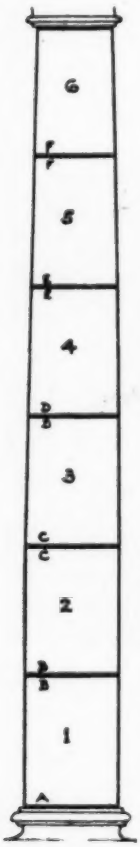
FIG. 11.—Partitions—correct and incorrect. Left hand partition has had groove scooped out, partition set in, and roll of clay laid in (on one side only for better illustration).—Correct. Right hand partition is merely set in against the face. —Incorrect.

Finishing of Columns.—The proper finishing of columns is troublesome. The usual method is to turn out the sections on the boards, and trust to luck that they fit. Usually they do not. One section is almost sure to project a bit over the lower, if it is a drum column, or if fluted, the flutes do not align. If one analyzes the thing, he will note in the case of drums that the end resting on the board does not shrink at quite the same rate as the free end. As this is the case with every drum when an end which has dragged on the board is fitted to the end which has been free to take full shrinkage, the end which has dragged is almost certain to project. The answer is obvious—mark the ends of the drums so that board ends go together, and free ends go together and then when drying has pro-

gressed sufficiently to warrant it, stack them on top of one another; finish them as a whole column and let the column dry as a unit.

The flutes not fitting is usually a case of finishing pieces separately, instead of the column being finished as a whole.

In the case of engaged columns or pilasters, the whole unit should be laid out on a single board and finished as a unit.



In handling columns and pilasters, it is assumed that enough molds have been furnished so that the whole unit can be pressed at one time. It would be impossible otherwise to finish the sections together, some of which are several hours drier than others. This matter of wet fitting requires care, but the results attained fully warrant the extra effort. The entasis of columns or batter of pilasters in no wise affects the procedure.

It is possible to manufacture almost any sort of terra cotta shape, provided it is given the proper amount of attention and nursing. This may mean excessive cost, but this really is the criterion of whether a given shape is commercially practical.

ATLANTIC TERRA COTTA CO.
TOTTENVILLE, N. Y.

Discussion

MR. ORTMAN:—Pressing is by all odds the most important operation in the manufacture of terra cotta. Most anyone can eventually work our glazes to fit a body, and it does not take very long to train a man to operate kilns, important and thoroughly technical though these are, but if you do not have a good, strong sound structural piece to start with, you are going to have poor ware.

We have not had, until this time, any paper of this sort presenting the good and bad practices in this most important operation. This is an excellent presentation of an important subject.

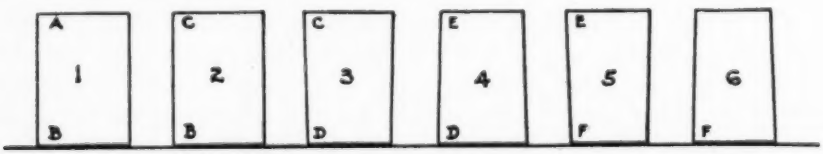


FIG. 12.—Correct method of turning drums of columns out on boards.

MR. W. D. GATES:—I think this is a very important subject. It occurs to me that we have been a little negligent in these practices. A great many defects may be caused by these initial strains that sometimes show

themselves as the ware goes on through the factory, and often only after it comes from the kiln or even after it is in the building. These initial strains are caused by imperfect pressing. It is in the pressing that the clay is put into a condition of uneven strain which, afterwards, causes a great deal of trouble.

A MEMBER:—Can a man do just as rapid work by the method proposed by Mr. Klinefelter as by the old method?

MR. KLINEFELTER:—Yes, if you break the presser into that way. He will never go back to the old thumb method. It is easier on the hand and arm. We have no trouble in maintaining this method of pressing under piece work system.

MR. GATES:—One point was not brought out; one layer is put in and then another layer and then the whole is pressed, and then you put in another layer. What do you do in that case?

MR. KLINEFELTER:—We are not advocating any change in the standard methods of pressing, but merely insisting on the use of the side of the hand or fist instead of the thumb.

MR. CLARK:—We are telling our employees all the time to keep their thumbs out of the corners. We have been trying to train the men to keep their thumbs away from the joints and corners, but they will use their thumbs in spite of our instructions.

If we could let the men see the damage they are really doing as shown by the defective pieces and demonstrate to them that afterwards those pieces might fail, we can sometimes show them that they have not paid proper attention to the joining and to the corners.

MR. TUCKER:—Mr. John Clark in his paper on pressing differs with Mr. Klinefelter in the matter of wiping up. On a small mold, Mr. Klinefelter's method might be satisfactory, but, as an instance, on a large ashlar mold, where the perimeter is very large or the area very large, the presser has to put in a large amount of clay for the face and wipe up all around. He wipes up the clay to zero thickness and then proceeds to put in the sides. By the time the presser gets to the third side, the thin wiped-up edges on the sides yet remaining to be pressed are dried out, especially so if he has a dry mold. It is evident that in cases of this sort it is quite difficult to obtain a weld between the fresh clay and the partly driedclay in the mold.

MR. KLINEFELTER:—It has been our experience that the size of the piece has not caused trouble from drying out. Work can be done as rapidly by this method as by any other.

MR. F. B. ORTMAN:—On the point with regard to the pulling in of the sides of the pieces due to the extra shrinkage of the partitions, I might mention that some companies have helped to overcome this trouble by using a clay in the partitions which will shrink less rapidly than does the clay of which the remainder of the piece is made.

On the question of welding of the partitions to the face and sides of the piece, I think that this is one of the most prevalent faults of the average presser. Not long ago I had occasion to visit a job where there was a failure due to movement in the building which caused a crushing strain to be brought on the face of the terra cotta, in some cases shearing the face off entirely, leaving the partitions and voids exposed. While I do not believe that poor pressing was the cause of these failures, in examining same after the face had been sheared off, I saw a great deal of evidence of poor pressing, particularly from the standpoint of welding the partitions to the face. There were a number of instances where the face had broken off from the partition in a clean sharp line without even leaving a mark in the pieces to show where the partition had been in contact with the face, showing clearly that no effort at all had been made to weld the partition in these instances.

If we could always be sure of having the partitions welded in, as Mr. Klinefelter suggests, it would greatly increase the crushing strength of our material in the building.

MR. CLARK:—Mr. Major Gates has a pressing machine that will bind a partition and the sides with the face so that it is impossible to see where they join together. It absolutely is one solid mass; I think that if we will emphasize the importance of good joining of the partition we will do away with a lot of our present troubles. With this machine the operator would not touch the clay. He just lays clay in whatever thickness the face, sides and partitions are to be and the whole thing gets a pressure of from 250 to 300 pounds per square inch. That gives a better weld than any pressure ever born could possibly make.

REFRACTORY CLAYS OF TEXAS

By J. H. Kruson

There are scattered, in different sections of Texas, many deposits of clays which appear to have refractory properties of sufficient value to warrant their use in the manufacture of low grade fire-clay products.

The bulk of the deposits being worked lie in the eastern portion of the State. Fire brick are manufactured at Denton, Elgin, Crush, Hopkins Co.; Butler Spur, Bastrop Co.; Elmendorf; Athens and Sulphur Springs.

These deposits, as a whole, are contaminated with foreign material so that only comparatively small sections are suitable for use. They are associated with lignite, free sand, (silica) running as high as 20%; iron (from 2 to 4%); and often the layers of sandstone separate the strata of clay.

The deposits in the northeast occur in lenticular form and vary in color and volume.

These clays generally are very plastic and dry; they break up in grinding into fine particles.

The following chemical analysis is an average representative of the so-called Refractory Clays of Texas:

	A	B	C
Silica (SiO_2)	70.05	74.04	77.75
Alumina (Al_2O_3)	18.80	15.15	11.04
Ferric oxide (Fe_2O_3)	3.07	0.50	3.19
Lime (CaO)	0.50	0.50	0.84
Magnesia (MgO)	0.30	0.27	0.38
Potash (K_2O)	0.29	0.42	...
Soda (Na_2O)	0.25	1.12	...
Titanic acid (TiO_2)	1.00	1.31	1.23
Water (H_2O)	5.74	6.70	3.75

Due to the peculiar working qualities of these high silica clays, the bricks are manufactured by the dry press process. The necessity for burning them to a temperature of 2350–2450°F before a good bond is developed may be due to the high silica content. Some grog is also used in the manufacture of these brick.

Fig. 1 will illustrate the refractory nature of these clays. Each sample is from a different location and is representative of the quality of ware produced.

The samples were broken in halves and marked. One half of each brick was subjected to the heat test and results are shown in Fig. 1, under the untested portion of the respective samples.

The samples were subjected to a straight heat test in an oil fired furnace together with samples of brick made from a second grade Missouri fire clay. At 2875°F the samples showed marked signs of swelling and deforming, which increased slowly until a temperature of 2950°F was reached,

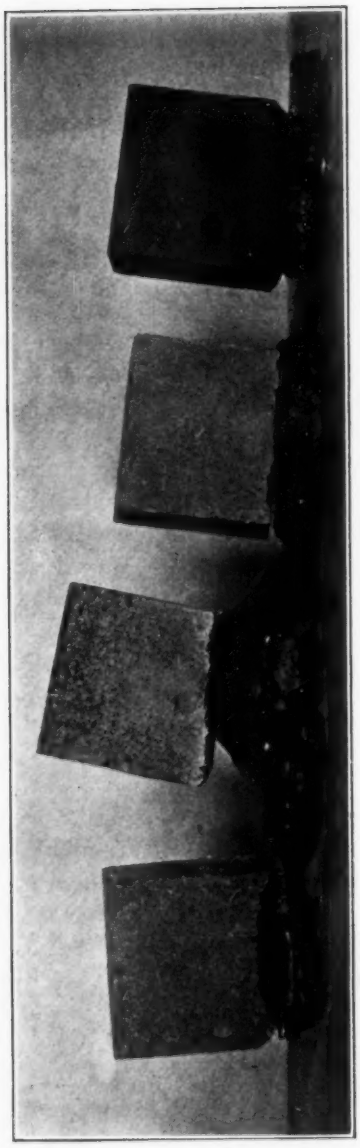


FIG. 1.

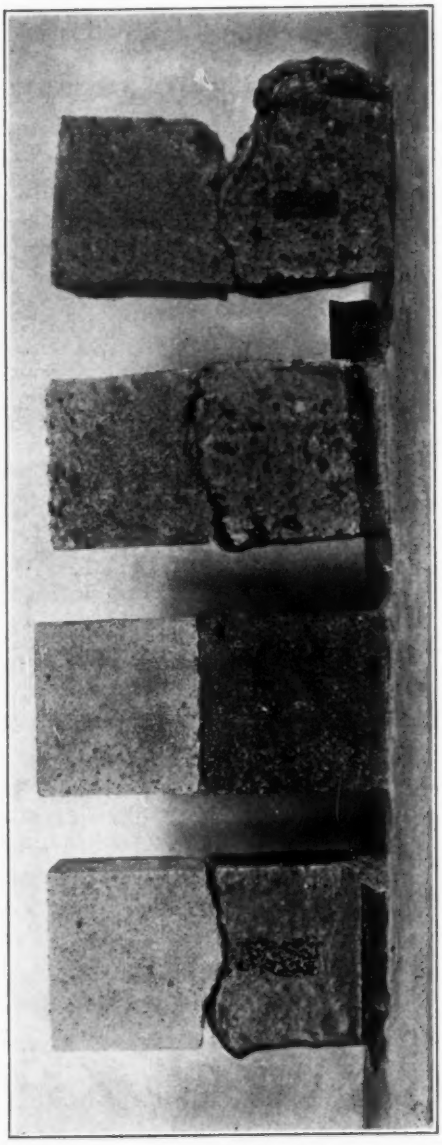


FIG. 2.

after which they failed rapidly and at a temperature of 2990°F (cone 28), they were fused until they had lost their original identity.

Fig. 2 shows the samples of some second grade Missouri fire brick in which grog is used. With these bricks the furnace temperature was brought up to 3000°F in about five hours, and the test completed in seven hours at a temperature of 3050°F or 60°F higher than that to which the Texas samples were submitted.

A. P. Green Firebrick Co.,
Mexico, Mo.

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[1] The abbreviation (*C. A.*) at the end of an abstract indicates that the abstract was secured from the Editor of *Chemical Abstracts* by coöperative agreement.

General and Miscellaneous

1. Canadian ceramic specialists for Canada. EDITORIAL. *Can. Min. Jour.*, **43**, 282(1922).—A movement has originated with the Canadian Clay Products Association and was discussed at the Toronto meeting in May, dealing with the establishment, at Toronto University, of a course in ceram. which would give to Canada ceram. engineers who had received both tech. training and practical experience at home. The ceram. industry is at present in an embryonic state but the raw materials for this industry, feldspar, silica rock, and china clay are plentiful, and steady progress is being made. This movement is a step in the right direction towards establishing an important new industry. O. P. R. O.

2. Bentonite. KEELE. Mines Branch, Canada Department of Mines. *Summary Report*, **160** (1918).—The variety of clay known as "bentonite" occurs in many localities in Wyoming but was first discovered in Canada in 1911 by Keele in an excavation in the town of Camrose, Alberta. Later discoveries of the clay have been made in the Edmonton formation of the Red Deer river and in the Nicola Valley, B. C. Description: When freshly exposed it varies from a light yellow to a light olive green with a waxy lustre. It is exceedingly fine-grained and has a scaly feeling when wet. It has unusual absorbent qualities being capable of taking up three times its weight in water, when it swells and becomes a jelly-like mass. Although refractory, it contains too high a percentage of fluxing impurities to be a fire clay. It cracks badly in drying. Chemical analyses of Camrose, Alberta, bentonite compared with that of Crook County, Wyoming:

	Crook County, Wyoming	Camrose, Alberta
Silica	61.08	69.14
Alumina	17.12	14.50
Iron	3.17	2.56
Lime	2.69	2.45
Magnesia	1.82	1.14
Potash	....	.19
Soda	.20	1.25
Sulphur trioxide	.80	1.70
Loss on ignition	12.10	7.71

Uses: Its chief use has been to give body and weight in the manufacture of paper. I has also been used as an adulterant of cheap candy and in the manufacture of antiphlogistine. Recently its use has been suggested as a sizing for yarns on account of the large proportion of colloidal silicate of alumina which it contains.... Further Investigation: Consequent upon inquiries directed to the Department of Mines by the Imperial Mineral Resources Bureau regarding possible sources of bentonite in Canada the localities mentioned above were again visited and work is now being done in the Mines Branch laboratory which will enable definite conclusions to be drawn regarding the suitability of Canadian bentonites for industrial purposes. O. P. R. O.

3. Clay and clay products industry of Canada. ANON. *Agric. and Indus. Progress in Canada* (C. P. R.), **3**, 2155(1921).—The clay industry in Canada is apparently on a healthy basis as the total value of products are as follows: 1920—$10,523,271; 1919—$7,906,366. In 1920 this was made up of common brick $4,868,958; pressed brick $1,756,760; fire-proofing $591,216; hollow building blocks $284,163; kaolin $15,022; terra cotta $120,875; pottery $207,410; sewer pipe $1,549,090; drain tile $619,442; other products $517,335. Canada's imports in 1920 were as follows: china clay $242,441; fire clay $276,139; pipe clay $2,442; other clays $151,760. Her total

imports of clay products in 1920 amounted to $10,781,592, principally from Great Britain and the U. S. Her total exports amounted to $323,989, of which $4,678 went to the United Kingdom, $240,128 to the U. S., and the balance to other countries. The principal centres of the clay mfg. industry are at St. John, New Brunswick; St. Johns, Quebec; and Medicine Hat, Alberta. O. P. R. O.

4. Building materials industry in Czechoslovakia. ANON. *Jour. Royal Soc. Arts* (London), **70,** 489–9(1922).—The building materials industry in Czechoslovakia occupies a very prominent position. This importance is due to the rich deposits of kaolin, clay and limestone. The brick industry is one of the oldest in the country; the number of workmen employed is 80,000; annual output 2,000,000,000 bricks and 200,000,000 tiles. Czechoslovakia contains 30 large and several hundred smaller kaolin mines and the output amts. annually to more than 20,000 wagons, of which 80% is exported. Porcelain is produced in 70 factories; the annual output exceeds 3,000 wagons, 70% of which is exported. The output of the magnesite mines is nearly all exported. 40,000 wagons of fire-proof bricks are exported. The pottery annual output amts. to 2,000 wagons, largely for export trade. There are 60 factories producing an annual total of 5,500 wagons of stone and chem. piping, largely for export trade. Flagstone industry is carried on in 12 factories, annual capacity 9,000 wagons: Portland cement, 12 factories, annual capacity 50,000, largely exported. Limestone, annual production 90,000 wagons, 10% exported. Among the natural building-stones there are numerous types of granite. Sandstone rocks are found and red, grey, and white marble are in abundance, annual export about 1,800 wagons. Building materials industry forms a group of the Federation Industrialists. There are special schools for pottery, brickmaking and stone-cutting, respectively, and the problems affecting these industries are studied from a scientific and a practical standpoint. O. P. R. O.

5. Experimental cottages. Farm colony at Amesbury. ANON. *Jour. Royal Soc. of Arts,* **70,** 508(1922).—Thirty-three experimental cottages, to test various methods of building with local materials, have been erected by the Ministry of Agriculture with the coöperation of the Dept. of Scientific and Industrial Research, London. Without expressing an opinion of the success or failure of the experimental features, the Department considers a description of the work may be of general interest and a report is now published which may be obtained from H. M. Stationery Office, London. The external walls of the several cottages are of brick, concrete, chalk and cement, rammed chalk, and straw and chalk pisé, respectively. Various experimental designs of floors, roofs, stairs, fittings and heating appliances have been used. O. P. R. O.

6. A Russian Fire Clay Concern. ANON. *Raw Materials Rev.,* **1,** 58(1922).—The Borovitch fire clay establishment is able to make a good rept. on its production of fire clay and other goods, which has improved monthly since last autumn, reaching its highest point in March, 1922, when its presses turned out 1,250,000 bricks against a million in January and February. The work per man per day has also improved, and is even better than pre-war. But for want of fuel the quantity fired has had to be reduced, so that some presses recently started will have to be stopped. The number of workers and other hands engaged at the factory is 1,433. O. P. R. O.

7. Some properties of commercial silicate of soda. JAMES G. VAIL. *Amer. Chem. Soc.,* (Sept. 2–6, 1919).—A discussion of the properties of commercial silicate of soda and its phys. characteristics. A definite compd. of the formula Na_2SiO_3 is easily prepd. in cryst. form from solns. containing sodium hydroxide and commercial sodium silicate. It crysts. with 9 mols. of water. It melts in its water of crystn. at about 40° C. It is rapidly decomposed by the carbon dioxide of the air. This product has no commercial significance. All the forms of sodium silicate in commercial use contain more silica than is indicated by the formula Na_2SiO_3, one grade having about 4 times

this amount. The ratio between sodium oxide, Na_2O, and silica, SiO_2, may be varied between 1 to 4 and 2 to 3. Products more alk. than the latter ratio are not made, on account of their tendency to form cryst. masses. The solns. of these different silicates vary largely in their characteristics. To take the two extremes; that with a ratio of 1 to 4, as above, may be concd. to about 37° Bé, which corresponds to about 34% total solids. In contrast to this type, a silicate with a ratio of 2 to 3 is thinly fluid at 37° Bé, and may be concd. to approx. 69° Bé, or about 62.5% total solids. Between these two extremes any intermediate grade can be produced; thus a considerable range of characteristics which are of importance in the adhesive uses of silicate of soda can be secured. As the propn. of alkali increases, the possible concn. increases, and there are in regular use different silicate solns. of 37°, 40°, 42°, 47°, 50°, 52°, 60° and 69°, each adapted especially for some commercial use. The colloidal nature of silicate solns. is indicated by b. p. but little higher than the b. p. of water. This is true even in the case of the 69° soln. which contains more than 62% of solids. The f. p. also are but slightly depressed from that of water. The ordinary 40 silicate freezes at about —3° C. When such a soln. is slightly warmed, the crys. tend to float. Solns. of above 60° Bé in concn. do not lose their transparency on freezing, but become progressively harder and finally brittle. Silicate of soda is pptd. by most salts of the heavy metals, and the ppts. are believed to contain free silicic acid along with metallic silicates. Pptn. is also effected by various liquids which tend to dehydrate the silicate soln. For instance, alc., glycerin, salt brine, and strong ammonia solns. will ppt. concd. solns. of sodium silicate. Such ppts. may be redissolved, but the second soln. has somewhat different characteristics from the original silicate soln. notably in respect to viscosity. The viscosities of solns. of silicate of soda are of interest in connection with many of its uses. The forms rich in silica rise slowly in viscosity until the condition of jelly is approached, when they rise very sharply. This is true whether the rise in viscosity is due to decrease of alkalinity, decrease of temp., or increase in concn. To prep. a silicate adapted as a quicksetting adhesive, use is made of this fact. A change from a liquid to a solid condition may occur with the loss of as little as 10% of moisture, this amt. being very quickly absorbed into a layer of paper board when the silicate is thinly spread on its surface. If suddenly exposed to a temp. above the b. p. of water, such a soln. will expand into a mass of permanent bubbles of beautiful white appearance and apparent sp. gr. as low as 0.01. Such a product is an excellent thermal insulator. Silicate of soda is the most convenient source of gels of silicic acid which may be prepd. with either alkaline or acid reaction by neutralizing more or less completely. Any mineral acid can be used for this purpose, and by varying concns. of acid and of silicate soln., gels of a wide variety of physical characteristics can be secured. Strongly acid gels have been used to prevent the splashing of acid from storage batteries. Very hard neutral gels have been used for prepg. material suitable for the adsorption of gases. The tensile strength of silicate of soda mixts. used for acid-proof cements is easily brought up to 1700 lbs. per sq. in. for air-dried briquettes, while the bond produced by baking silicate of soda and clay, as is the practice in the manuf. of abrasive wheels, easily yields a strength above 2000 lbs. per sq. in. F. H. R.

8. Producer gas plant design. R. F. Clewell. *Glass Industry*, **2**, 283–7(1921); **3**, 5–9, 32–6(1922), 11 figs.—Plant design for the manuf. and distribution of raw producer gas is discussed in detail under the following heads: Plant location, plant capacity, selection of equipment, provision for future extension, arrangement and accessibility of equipment for ease of operation and maintenance, and the gas-distributing system. J. B. Patch (*C. A.*)

9. The importance of clean gas for the producer plant. F. J. Denk. *Glass Worker*, **41**, No. 27, 12, 36–8(1922).—The savings resulting from the use of small gas pipe in-

stead of large brick-lined mains together with repairs and cleaning, etc., of lines and regenerators pay for the cost of producing clean gas which is also more efficiently used in the furnace. J. B. PATCH (*C. A.*)

10. Graphical treatment of stack gas analysis and of producer gas analysis. W. TRINKS. *Blast Furnace Steel Plant*, **10**, 131–5(1922).—A review of charts introduced by W. Ostwald and developed by Claus and Neussel. (Cf. *Ceram. Abs.*, **1**, 154(1922). C. E. CARLSON (*C. A.*)

11. Electrical precipitation. H. J. BUSH. *J. Soc. Chem. Ind.*, **41**, 21T–28T(1922); cf. *C. A.*, **15**, 2587.—An interesting review with bibliography and drawings of installations. Elec. pptn. is now in use all over the world. If has been applied to the pptn. of H_2SO_4, precious metal dust, potash, particles from blast furnaces and pyrite burners, lead smelter fumes, tin furnace fumes, alumina, calcining furnace gases, waste gases from evaporators of sulfate liquors from cellulose works, gases from coal briquetting furnaces, copper converters, McDougall roasters and to the purification of and removal of bacteria from air. D. MACRAE (*C. A.*)

12. Modern tunnel-kilns. A. E. BUCH. *Kalk Gips- u. Schamotte Ztg.*, **28** (June 21, 1921); *Chimie et industrie*, **7**, 518(1922).—A discussion of the merits and advantages of modern tunnel kilns in the ceramic industry, together with a description of the Buch, Möller and Pfeifer, and Dressler systems. A. P.-C. (*C. A.*)

PATENTS

13. Zinc oxide. F. C. W. TIMM. U. S. 1,409,318, Mar. 14. Zn-bearing slags or the like are placed on a layer of dezincing material such as C, lime and Fe compds. and hot combustion gases are passed through the charge and gases laden with ZnO are withdrawn from below. (*C. A.*)

14. Phonograph needles of shale or clay. M. T. STRAIGHT. U. S. 1,409,498, Mar. 14. Needles of shale or clay are heated to near the m. p. and then gradually cooled. (*C. A.*)

Apparatus and Instruments

15. The new radiation pyrometer of Hase. ANON. *Gieserei Ztg.*, **9**, 31–2(1922).—An illustrated description of an instrument for foundry practice. It is a compromise between scientifically precise app. like the Wanner pyrometer and the comparatively crude pyroscopes so generally used. It is a modification of the Féry pyrometer, in which the sensitivity of the radiation receiver is greatly increased. It is in the form of a telescope weighing 2.5 kg. and can be used by hand. The temp. can be read by direct observation, and the indicator is so adjusted that temp. variations in short periods can be detected. From 1 m. or greater, the reading is independent of the distance. The temp. ranges are 700–1400°, and 1200–2000°, and at 1000° an error not over 10–15° is practicable. C. C. DAVIS (*C. A.*)

16. Improvements in measuring apparatus for gases, vapors, liquids and granular substances. F. M. BAYER. *Chem. App.*, **8**, 59–61, 67–9, 88–90, 94–6, 161–3, 170–3, 179–81(1921); **9**, 22–4, 52–4(1922).—A review of Ger. patents, with 60 cuts. J. H. M. (*C. A.*)

17. Conveying machinery in the chemical industry. GEO. F. ZIMMER. *Chem. Age* (London), **6**, 230–33(1922); cf. *C. A.*, **15**, 1967.—This article covers bucket elevators and band and reciprocating conveyors. It is suggested that stainless steel and high Si irons be used for chem. plant elevators, etc. A. E. MARSHALL (*C. A.*)

18. Disappearing filament pyrometer. ANON. *Engineering*, **113**, 501(1922).—This paper describes an optical pyrometer of the disappearing filament type in which

the optical system, lamp, rheostat and meter are in one compact unit. In order to utilize the full scale of the meter the latter is connected in a special way. The lamp is placed in one arm of a Wheatstone bridge, the other three arms being manganin resistances. By this device the scale of the meter may be so calibrated as to begin with the lowest temp. which the instrument will read, thus eliminating the useless portion of the scale. The range is from 700 to 1200° with current flowing in one direction and from 1200 to 1510° when the direction is reversed. Absorption screens are used for higher temps., and the accuracy is about 5°. DONALD E. SHARP (*C. A.*)

PATENTS

19. Apparatus for drying and medicating air. C. DOBBS and A. E. PAINTER. U. S. 1,409,364, Mar. 14, 1922. (*C. A.*)

20. Detachable puddle rod and blade. L. W. JONES. Can. 217,403, Mar. 28, 1922.—A melting pot has a tubular shaft arranged for operation therein and arms or blades, which are substantially triangular in cross section and have inclined openings therethrough, carried by the lower portion of the shaft. (*C. A.*)

21. Separating solid materials. S. NETTLETON. Brit. 174,739, Nov. 2, 1920. For sep. solids, *e. g.*, sepg. stone, shale, etc., from coal, the mixt. is delivered at a suitable velocity on to one or more flat horizontal rotating disks upon which the constituents are deflected to different degrees according to their frictional coeffs. The mixt. may be delivered by inclined shoots to the disks. A suitable construction is specified. (*C. A.*)

Chemistry, Physics and Geology

22. Physical chemistry and ceramics. EDWARD W. WASHBURN. *Jr. Franklin Inst.*, **193,** 6, 749(1922).—The application of phys. chem. to the soln. of ceram. problems is discussed under the fol. heads. (1) Colloid chem., (2) heterogeneous equilibrium at high temps., (3) properties of silicate solns. at high temps. including d., elec., cond., viscosity and surface tension, (4) standard methods of testing ceram. materials. Data on the viscosity and surface tension of the system Na_2O-SiO_2-CaO is given. R. J. M.

23. Stratification of clay suspensions and its use in the determination of the size of clay particles. ERNST UNGERER. *Kolloidchem. Beihefte,* **14,** 3–5, 63–96(1921) (R. RIEKE). Suspensions of known substances such as ultramarine blue are made, different fractions obtained by centrifuging and the particles in each strata counted, weighed and measured as described in the article. By this means data of the following nature is obtained:

TABLE I

Suspension	Time of centrifuging in min.	Weight of one particle	Diameter of one particle
Ultramarine blue number 8	2 ½	$1.79 \cdot 10^{-11}$g	$2.08 \pm 0.038\mu$
"	3 ½	$1.34 \cdot 10^{-11}$g	$1.76 \pm 0.041\mu$
"	4 ½	$0.80 \cdot 10^{-11}$g	$1.23 \pm 0.004\mu$
"	4 ½+	$0.30 \cdot 10^{-11}$g	$0.86 \pm 0.009\mu$

The size of the particles was also determined by means of Stokes' Formula from which the following relation is obtained—

$$r = \sqrt{\frac{9}{2} \cdot \frac{n}{D-d.g}} \cdot \sqrt{v}$$

when

r = radius of particle
n = viscosity of fluid
D = density of fluid
d = density of particle
v = rate of fall of particle

This formula gives results which check very closely with those obtained by direct measurement as described. A clay suspension was then studied and following data obtained:

TABLE II

Time of standing	Height in cm. of				
	1 layer	2 layer	3 layer	4 layer	5 layer
96 hours	...	1.8	2.7	3.6	7.9
144 "	1.2	2.1	3.6	5.4	12.2
192 "	1.4	2.6	5.0	7.8	16.7
240 "	1.9	3.8	6.5	10.7	20.3
Size of particle (calculated)	0.151μ	0.213μ	0.278μ	0.344μ	0.497μ
Size of particle (measured after 240 hours)	...	0.200μ	0.297μ	0.332μ	0.527μ

The writer also demonstrated the adaptability of Stokes' Formula to the study of soil suspensions and of emulsions. Several conclusions covering the characteristics of the strata and the conditions under which they will form are added. R. F. G.

24. A new source of soapstone in Ontario. H. S. SPENCE. *Memorandum No. 4, Mines Branch,* Dept. of Mines, Canada (April, 1922).—An extensive deposit occurs at Wabigoon Station on the main line of C. P. R. near Dryden, Ontario, and is distant only 500 yards from the railroad. It is well situated for working but no development work has yet been conducted. Tests of the stone for crushing strength, transverse strength, corrosion, absorption, fusion temperature, as well as chemical-analyses, have been made in the Mines Branch laboratory and show the deposit to be a very high grade. In appearance and composition (as shown by analyses) it is very similar to the so-called "Alberne Stone" quarried extensively in Virginia. The use which suggests itself most strongly for the stone of this deposit is for bricks for lining the smelting furnaces of sulfate pulp mills, which require a refractory material which is structurally strong and does not crack under heat. The dozen or more of such mills in Canada would benefit greatly if the Wabigoon stone proves profitable for working, as at present all such material has to be imported. The report concludes with the words, "This deposit is the most promising from an economic standpoint of any of the soapstone occurrences seen in Canada." O. P. R. O.

25. Fire brick manufactured at Clayburn, British Columbia. WILLIAM FLEET ROBERTSON. British Columbia. *Annual report of the Minister of Mines,* N 28 (1921).

—A bed of excellent fire clay, occurring in bedded rocks of the Eocene age, is found in commercial quantities near Clayburn. Shales, sandstone, and conglomerates, all but little consolidated, make up this sedimentary series. Fire brick is the principal manufactured article produced by the Clayburn Co. Ltd., but in addition common brick, paving brick, tile, drain-pipe and prepared fire clay are made. Associated with these rocks is a bed of lignite which is sufficiently good to be used for firing the boilers of the fire-brick plant. O. P. R. O.

26. Talc in Canada. M. E. WILSON. *Can. Min. Jour.*, **43**, 356(1922).—Deposits of talc or soapstone occur throughout Canada in Nova Scotia, British Columbia, Ontario and Quebec, but most of these, so far as development work has shown, are either limited in extent or impure, so that the only extensive known deposits of high grade talc in Canada are those occurring in Ontario. The rocks with which these deposits are associated consist almost entirely of dolomite, quartzite and interlaminated quartz and dolomite, but batholithic masses of granite occur nearby. O. P. R. O.

27. Talc in New Zealand. P. G. MORGAN. *New Zealand Jour. of Sci. and Tech.*, **2**, 112(1919).—There are numerous occurrences of talc (also called soapstone, steatite, French chalk, or potstone) in N. Z. Some of these appear to be of good quality. At the present time colored French chalk for tailors' use is being sold in N. Z. at something like 10s. per pound, and the manufacture of crayons, etc., from local talc appears to be a feasible undertaking for any person acquainted with the technical details. Crystalized talc of great purity is found in small pockets here and there in association with the talc and serpentine rocks of north Westland; green talc schists are also common; but owing to the difficulty of access none of these talcose rocks have economic value at the present time. O. P. R. O.

28. Clay and fullers' earth in New Zealand. P. G. MORGAN. *New Zealand Jour. of Sci. and Tech.*, **2**, 119(1919).—On account of an urgent demand for fullers' earth suitable for use as a clarifying medium, the Geological Survey has given further attention to the subject and largely through inquiries and investigations made by the Survey and the Dominion Laboratory, it is believed that at least three satisfactory sources of fullers' earth have been discovered—one at Glen Massey, Waikato district; another at Croydon, near Gore; and the third at Hokonui, Southland. In addn. to these many other clays have been found to possess considerable clarifying power—some exceptionally good quality for use as fire clay and some valuable for porcelain. O. P. R. O.

29. Graphite in New Zealand. P. G. MORGAN. *New Zealand Jour. of Sci. and Tech.*, **2**, 207(1919).—The numerous records of graphite occurrences in New Zealand indicate a probability of workable deposits being found if search is made. Three kinds of natural graphite—namely cryst., flake, and amorphous—are mentioned in market repts. Cryst. graphite is the nearly pure material, found in pockets and lenses, which can be put on the market without any preliminary treatment. At the present time by far the largest supplies come from Ceylon. Flake graphite is the same material as cryst. graphite, but has been produced from less pure deposits by some process of concentration. Amorphous graphite is in part not true graphite at all, but altered coaly material which has lost all its hydrocarbon, though it has not undergone the mol. change required to reach the stage of graphite as known to the mineralogist. Such material has no heat-resisting power, nor is it suitable for the manufacture of lead-pencils, etc. A bibliography on graphite is given. O. P. R. O.

30. Polo halite in Italy. ANON. *Raw Materials Rev.*, **1**, 43(1922).—A mineral of great utility to the glass industry and for soap-making has been found at Calascibetta in the valley of the Morelle River at Sicily. It has been named "Polohalite." A dip has disclosed the following formation:—Saline marle containing gypsum, chloride

of sodium 2 m., sulfates of various bases 14 m., sulfate and chloride of sodium 4 m., other sulfates of various bases, marle and gypsum in great masses. It is hoped to exploit these deposits for glass works, and to a certain extent for soap making. O. P. R. O.

31. Bauxite in Italy. Anon. *Raw Materials Rev.*, **1**, 43 (1922). Large deposits of bauxite are known to exist in New Italy, particularly in Istria. It is not equal to the bauxites of Sangiunge or of the Abruzzi which are highly prized as the basis of a large national production of metallic aluminium, oxide of aluminium, and sulfate of aluminium. The Istrian bauxite does not average more than 55% of oxide of aluminium, but the deposits being near to the Austrian and German frontiers, may be exploited for export of this valued raw material to the industrial districts of Germany, which country during the war developed a most important industry in oxide of aluminium and metallic aluminium. The difference of cost of transport from Istria to South Germany as compared with that of French bauxite via Rotterdam shows the possibilities of the export of the Italian material. O. P. R. O.

32. Sicilian sulfate of soda. ANON. *Raw Materials Rev.*, **1**, 43(1922).—Several important sulfate of soda deposits have been identified in Sicily; particularly one at Bompensiere in the province of Caltanissetta, and one near Calascibetta in the same province. The deposit at Bompensiere is principally Glauberite, that is, sulfate of calcium and sulfate of sodium combined. But the constituent of the upper layers is principally pure sulfate of soda, transparent and vitreous. New methods of working have made the exploitation of these fields possible at a profit. Taking advantage of the different solubility of the salts it is proposed to dissolve them in water; the gypsum becoming residuum would crystallize the sulfate of soda. If one crystallization does not suffice, it is proposed to repeat the process until complete purification results. Instead of extracting the mineral and treating it in large shallow basins, thus obtaining the saturated solution, warm water is to be introduced into the mine, and when it is saturated with the salt, it will be pumped up as is done at Stassfurt. In this way advantage is taken of the poorer mineral. With the Glauberite there is also found some chloride of sodium. O. P. R. O.

33. World's graphite production. (1921). ANON. *Can. Min. Jour.*, **43**, 233.—Production in 1921 was less than at any time since 1902. Canada and Ceylon fell greatly behind pre-war tonnages. Dorea held its own. Germany alone forged ahead with an increase of 50 per cent more than 1920. O. P. R. O.

34. Fluorspar in British Columbia. WILLIAM FLEET ROBERTSON. *B. C. Annual Rept. of the Minister of Mines*, **No. 24**(1921).—The development work done by the Consolidated Mining and Smelting Co. of fluorspar concn. for the last two or three years has been very interesting. The Co. is now equipped with an efficient concg. mill. It produced during the year some 7,500 tons of fluorspar concentrates, carrying 87% calcium fluoride and 6% silica; and having a total value of about $175,000. The mineral is used for making hydrofluoric acid, in lead refineries in Canada and the U. S. O. P. R. O.

35. Dutch bauxite. ANON. *Raw Materials Rev.*, **1**, 58(1922).—Bauxite mines are being worked by an American company at Moengo, in the Dutch colony of Surinam. Bauxite, the ore from which aluminium is extracted, found in Surinam, Dutch East Indies, has an aluminium oxide of 55 per cent. The Bauxite Company owns twenty-two sea and river barges and seven launches, and the Aluminium Line sends its vessels to Surinam to fetch the ore to America, where it is smelted. In Surinam itself the ore is dried only; the aluminium is extracted in the furnaces in America. The quantity of ore at Moengo is estimated at 10,000,000 tons. A good harbor is to be made there in order to ensure quicker shipment of the ore. O. P. R. O.

36. Cobalt oxide in Canada. CHARLES W. DRURY. *Ont. Bureau of Mines Rept.*,

27, Pt. 3, 31(1918).—Previous to 1903, Europe controlled the world's supply of cobalt. Since its discovery in Canada at that time, very little has been mined outside of that country. Canada produces from the cobalt ore a very high grade cobalt oxide, which is much in demand by the ceram. industries of Europe, and does this at about one-half the price that the low and medium cobalt compds. or smelts were sold in Europe ten years ago. In reviewing the metallurgy of cobalt the change is noticeable; in the European refineries ores were treated for the cobalt content alone, while from the ores of Canada, metallic silver, cobalt, nickel and arsenic oxide are recovered. The associated metals are often a source of revenue for the smelters. O. P. R. O.

37. Potash from feldspar. SYDNEY JOHNSTONE. *Imperial Institute Monograph*, (1922).—This monograph deals with the sources of the world's supply of potash and among these the feldspars of Canada attract great attention, for while the problem of extracting potash from feldspar economically has not yet been solved, investigation continues and Canada's abundant supply of this source promises much for the future. A process is now on trial at the works of the National Portland Cement Co., Durham, Ont. O. P. R. O.

38. The separation of ferric iron and aluminium from calcium by the nitrate method. CHARRIOU. *Compt. rend.*, **174,** 751–4(1922).—St. Claire Deville proposed the sepn. of Fe and Al from Ca on the basis of the fact that the nitrates of the trivalent metals are decomposed by heat, leaving an insol. oxide whereas the nitrates of alkaline earth metals are less readily decomposed and the oxides are much more sol. in water. A sepn. carried out on this basis is usually unsatisfactory because a little alkaline earth is likely to be held back in the residue of oxides. This entrainment of CaO is found to be very appreciable but is less if the nitrates are decomposed at a fairly low temp. (150°) and if the oxides are subjected to repeated treatments with boiling 5% NH_4NO_3 soln. If the residue contains this substance the entrainment of CaO is prevented but the insol. oxides are so pulverulent that they are likely to run through the filter. The most satisfactory method of working seems to be that of adding a slight excess of NH_4OH before evapg. to dryness. Then, after the ignition, treatment with NH_4NO_3 soln. serves to dissolve out all the Ca. If Al is present, however, the filtration is tedious so that it is advisable to wash the residue twice by decantation, then dissolve it in boiling HNO_3 and ppt. again with NH_4OH. It is difficult to remove all of the oxides from the dish in which the ignition took place. This difficulty may be overcome by weighing the dish at the beginning and end of the process, to find the amt. of adhering oxide, or by dissolving the residue in acid and pptg. by NH_4OH. W. T. H. (*C. A.*)

39. Specific heat of solids at high temperatures. M. BORN AND E. BRODY. *Z. Physik*, **6,** 132–9(1921).—A mathematical paper in which are considered the quantum theory of an oscillator system of large amplitude of vibration, and the statistics of the oscillator system. For the at. heat at const. vol. (C_v), the following expression is deduced: $C_v = dU/dT = 3R(1-6\sigma RT)$, where the quantities have their usual significance. From exptl. data it is shown that $C_v = 5.8546 + 0.000649T$.

H. J. C. (*C. A.*)

40. Weighing by substitution. C. A. BRIGGS AND E. D. GORDON. Bur. of Standards, *Tech. Paper*, **208,** 177–92(1922).—Sp. directions are given for weighing by substitution, as developed by the Bur. of Standards for the testing of large weights. This paper is written especially for makers of scales and weights.

C. E. CARLSON (*C. A.*)

41. A new occurrence of cristobalite in California. A. F. ROGERS. *J. Geology* **30,** 211–6(1922).—In obsidian from San Bernardino Co. ($n = 1.483, \pm 0.003$), are rod-shaped crystallites in parallel lines, and spherulites 5–25 mm. in diam. The solid

portions of the spherulites consist of orthoclase and cristobalite, in fibrous aggregates which on microscopic examn. prove to be intergrowths. Other minerals identified include tridymite, opal, magnetite and fayalite. The cristobalite was formed at a high temp. and as the temp. became lower, tridymite appeared, and at about the same time fayalite and magnetite. The opal is the only mineral formed by ordinary solns.

W. F. H. (*C. A.*)

42. The representation of igneous rocks in triangular diagrams. ALBERT JOHANNSEN. *J. Geol.*, **30,** 167–9(1922).—By means of a dot and a line J. plots, without the use of a slide rule or any calcn., the actual % of quartz, orthoclase, plagioclase, and dark minerals, as well as their relative % among the light constituents. W. F. H. (*C. A.*)

43. Sizes of atoms in crystals. R. N. PEASE. *J. Am. Chem. Soc.*, **44,** 769–74 (1922).—It is shown that the contribution of an atom to the distance between it and another in a crystal depends on the no. and arrangement of electrons about its positive nucleus, on the type of lattice, at least as this affects the lattice, and, ordinarily, on the magnitude of the charge carried by the atom, and that the particular element is of secondary importance, *for elements whose atoms are of the same rare-gas type.* The inter-at. distances in crystals of the diamond type of lattice have been analyzed from this point of view. H. JERMAIN CREIGHTON (*C. A.*)

44. The influence of the concentration of colloids on their precipitation by electrolytes. H. B. WEISER AND H. O. NICHOLAS. *J. Phys. Chem.*, **25,** 742–57(1921); cf. *C. A.*, **16,** 1351.—The colloids, hydrous chromic oxide, Prussian blue, hydrous ferric oxide, and arsenious sulfide were used with 1- and 2-, and 3- or 4-valent pptg. ions. The pptn. values of all electrolytes decrease as the concn. of the colloid is lowered in all cases except As_2S_3 with univalent pptg. ions. With As_2S_3 the pptn. value of electrolytes with univalent pptg. ions increases with decreasing concn. of colloid. The 2 opposing tendencies due to diln., the smaller concn. of colloid which required less pptg. ion to neutralize it, and the greater dispersion which required a greater concn. of pptg. ion to secure collisions, have been assumed to be the principal factors in detg. the relation between concn. and pptn. Another more important factor is the effect of the adsorbability of the oppositely charged ion which may be absorbed and stabilize the colloid. F. E. BROWN (*C. A.*)

45. Studies on specific heats. III. M. PADOA. *Gazz. chim. ital.*, **52, I,** 25–9 (1922); cf. *C. A.*, **15,** 1844.—In the preceding paper P. showed with exptl. data that the multiplication and intensification of bonds between atoms in solid polymerized compds. produces a marked diminution of the sp. heat. Reasoning in the same way elements whose sp. heats are markedly lower than required by the law of Dulong and Petit ought to have a considerable no. of valences. In solid solns. of an element abnormal in this respect in an excess of an element normal in its sp. heats, it should be possible to detect an increase in the sp. heat of the abnormal element. Abnormal elements capable of giving solid solns. in normal elements are not numerous. C is sol. in Fe only to the extent of 2% and could not be used. Si, however, forms solid solns. up to 18% Si in Fe. Detns. of the sp. heat of alloys contg. 10.14, 33.6 (FeSi), 50, 75, 85 and 95% Si gave values for the at. heat as follows: 6.42, 6.04, 5.27, 4.83, 4.78, 4.75 and 4.74, resp. The data for FeSi were taken from Schimpff (*Z. anorg. Chem.*, **71,** 257(1910)). The results show that the sp. heat of Si rises in solid solns. as the diln. increases although an extra high value (6.64) was taken for Fe. "The formation of the solid solns. thus corresponds to a pulverization into free atoms of Si and produces the effect of restoring to them the degree of freedom necessary in order that the energy content proper to the thermal oscillations may rise to the level characteristic of most of the metals." Results equally satisfactory for Se in the system S-Se were obtained. In the system S-Se solid solns. contg. 4, 9, 28.77, 90.35% (rhombic and monoclinic

forms of this mixt.) at. heats for S of 7.03, 6.00, 5.87, 5.50, 5.78, resp., were obtained. Here also the at. heat is max. for the greatest diln. of S. In Se-Te in which both components are normal the sp. heats were additive, as they should be. E. J. W. (*C. A.*)

46. A simple formula for calculation of the specific heats of solids. H. J. KRASE. *J. Am. Chem. Soc.*, **44**, 784–6(1922).—This is an empirical equation for representing the empirically and graphically found values given by Lewis and Gibson (*C. A.*, **12**, 14). The agreement is out 30% or so at very low temps., is good to about 2.5% at the characteristic temp. Θ, the temp. for each substance for which C_v (per gram atom) = 2.96, and to 2 to 4 per mille if T is 1.6 or more times Θ. The equation is: $C_v = 2.91 + 2.89 \tan h\, 2.95 \log T/\Theta$. W. P. WHITE (*C. A.*)

Refractories and Furnaces

47. The composition and micro-structure of clays and their fusibility at high temperatures. LÉON BERTRAND. *Ceramique*, **25**, 153–157(1922).—The relation between the Al_2O_3 content and fusibility of 101 clays were studied and the results are summarized in the following table:

% Al_2O_3	No. of clays	Softening temps. °C	% Al_2O_3	No. of clays	Softening temps. °C
39	1	1840	25	5	1450–1790
38	1	1850	24	4	1450–1800
37	1	1830	23	8	1390–1790
36	3	1190–1830	22	7	1440–1790
35	2	7790–1800	21	3	1270–1720
34	4	1810–1830	20	3	1120–1770
33	7	1670–1810	19	1	1450
32	2	1750–1810	18	1	1720
31	6	1670–1810	17	1	1650
30	3	1700–1790	16	4	1160–1710
29	5	1690–1790	15	1	1650
28	7	1430–1810	14	2	1460–1690
27	7	1500–1770	12	2	1390–1670
26	9	1470–1770	8	1	1650

The clays were classified into three groups as follows: I.—Clays containing more than 29% Al_2O_3 (more than 32% for fired clays). All clays in this group were fire clays having a softening point above 1650°C. II.—Clays in this group contain 20–28.9% Al_2O_3 (21.5–32% Al_2O_3 for fired clay). This group consisted of 53 clays softening between 1120–1810°C and 39 of these soften above 1650°C. III.—Clays in this group contain less than 20% Al_2O_3 (less than 21.5% Al_2O_3 for the fired clay). This group contains 13 clays which soften between 1160–1710°C of which 7 soften above 1650°C. Since those clays which have the highest Al_2O_3 content are generally the most refractory B. recommends that a minimum Al_2O_3 content be specified for clay refractories.

H. G. SCHURECHT

48. Open hearth furnace design. A. D. WILLIAMS. *Iron Age*, **109**, 577–9, 717–9, 853–5, 1075–6(1922); cf. *Ceram. Abs.*, **1**, 108(1922).—Design, computations and figures are based on known principles and chem. reactions that take place. The calcn. of the hearth area is such as to give a metal depth of about 29 in. in a 100-ton furnace. The inclination of parts varies with practice, being a function of speed vols., etc. The velocities of the gases det. the inclination of ports and similar openings. Regenerator computations for wt. and vol. of checker work require 50 to 70 lbs. per lb. coal burned per

reversal, the temp. changes being based on the time of reversals. For frictional resistance in the design of checkers and flues the formula of Mojarow is used. Calcns. of the gas and air necks, flues, etc., are also based on this formula. The consideration of the port areas and velocities of the gases is affected by the pressures as are also the angles and locations. The pressure of the gas may be from $^1/_2$ to 1 in. of water, but not more than the capacity of the flues for carrying off the gases. The height of the stack varies, depending on the use of auxiliary draft appliances.

W. A. MUELLER (*C. A.*)

49. Chromite deposits of Bahia, Brazil. H. E. WILLIAMS. *Eng. Mining J.*, **111,** 376–8(1921).—There is a large chromite deposit near Santa Luzia; lenses with amphibole in a quartzose gneiss. Extensive mining was carried on during the war.

E. F. H. (*C. A.*)

50. Alunite deposits in United States. RICHARD H. TINGLEY. *Rock Products,* **25,** No. 6, 38–43(1922).—A popular account of some of the alunite deposits in Utah and the prices and extent of the demand for K, alum and H_2SO_4 in the U. S. Roasting and treating with H_2O is the process proposed. The crude Al_2O_3 remains behind and the K_2SO_4 goes into soln.

J. O. HANDY (*C. A.*)

51. The preparation of refractory bodies for temperatures over 2000° in furnaces with reducing atmospheres. OTTO RUFF. *Forschungsarbeiten Gebiete des Ingenieurwesens,* **1914,** No. 147, 31 pp.—The only oxides or furnace linings which are sufficiently high-melting, non-volatile and resistant at 2000° to the reducing atm. of a C resistor are BeO, MgO and ZrO_2. Of these three ZrO_2 alone is practical; BeO is too expensive and MgO too volatile. The 2 latter can serve only as fluxes. Impervious crucibles can be prepd. from ZrO_2 which are resistant up to 2200° in an evacuated C resistance furnace. The addn. of dry starch makes ZrO_2 more easily molded. MgO increases the shrinkage at low temp., but gradually disappears at temps. above 2000°. Entirely impervious crucibles of ZrO_2 have not yet been made. The prepn. of impervious crucibles with TiC is very difficult; it is facilitated by the addn. of a small amt. of other carbides although good vitrification has not yet been obtained. The requirement is that the m. p. and the vitrifying point must occur at a rather wide difference of temp. ZrC_2 is about the only other carbide sufficiently stable to serve as the basic material for such crucibles. Suitably glazing porous C crucibles may prove possible and further work along that line is promised.

H. I. MATTILL (*C. A.*)

52. Vanadiferous asphaltites of central Peru. J. G. BARAGWANATH. *Eng. Mining J.*, **111,** 778–81(1921).—Vanadiferous asphaltites of the impsonite type are found in Junin and Lima, along the western Cordillera of the Andes of central Peru. They occur in lenses in limestone, and contain as much as 16% ash, 2–5% S, 1% V. Several analyses are given. Attempts to extract the V by burning and treatment of the ash have proven unprofitable.

EDW. F. HOLDEN (*C. A.*)

53. Cleaning producer gas without washing. J. H. MATHESON. *Iron Age,* **109,** 916–7(1922) 4 figs.—Description and advantages are given of an installation for mixing the gases from several producers and removing the dust therefrom by an impact and settling process. A saving of 20–25% of the fuel is made. The dust recovered is valuable as a fuel.

J. L. WILEY (*C. A.*)

54. Chemistry and physics of gas works refractories. T. F. E. RHEAD. *Gas World,* **76,** 225–7, *Gas J.*, **157,** 633–6(1922).—Attention is drawn to the influences of grading, proportioning, mixing, molding pressure, burning, etc. J. L. WILEY (*C. A.*)

55. The application of electric power in the iron and steel industry. W. S. HALL. *Assoc. Iron Steel Elec. Eng.*, **4,** 127–51(1922).—H. discusses the various sources of waste heat from steel plants and its conversion into elec. power. Also in *J. Western Soc. Eng.*, **27,** 145–57(1922).

W. E. RUDER (*C. A.*)

56. California silica sand operations. (GUNNEL) **18. Preparation of refractory bodies for temperatures over 2000°** (RUFF) **4.** (*C. A.*)

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57. Carbon electrodes; abrasives. W. G. MICHEL. Brit. 174,529, Feb. 11, 1921. C electrodes for electrolysis, furnaces, arc lamps, or batteries, are made of abrasive bodies, such as are used for grindstones, emery wheels, and hones, by compressing the powdered C, emery, carborundum, etc., in a mold, exhausting air from the mold, allowing heated binding material to permeate the powder, and baking the resulting bodies. A suitable construction is specified. Cf. *C. A.*, **15**, 3033. (*C. A.*)

58. Electric crucible furnace. W. S. HADAWAY, JR. U. S. 1,410,566, Mar. 28, 1922. (*C. A.*)

59. Electric arc furnaces. F. VON SCHLEGELL. Can. 216,774, Mar. 14, 1922. A pair of parallel electrodes is inserted in a chamber in proximity to each other in such a way that the distance between them may vary under the influence of the magnetic fields set up in the furnace. An auxiliary electrode movable to contact with the pair of electrodes to form an arc may also be provided. (*C. A.*)

60. Manufacture of refractory and insulating products. G. L. DIMITRI AND J. E. DELAUNAY. Can. 217,417, Apr. 4, 1922. A natural Mg silicate is mixed with other silicates; the mixt. is compressed, dried, formed into blocks and fired at about 1450° in a muffle furnace. The compression may take place in a vacuum. Cf. *Jour. Amer. Ceram. Soc.*, **4**, 865 (1921). (*C. A.*)

61. Electric furnace for zinc purification. H. TSUBOI. Jap. 38,656, May 14, 1921. Diagrammatical description of an elec. furnace for purification of Zn by distn. A plug having a small hole is put in the delivery hole of the condensing chamber, by means of which formation of powdered Zn is prevented. (*C. A.*)

62. Tilting electric furnace. W. E. F. BRADLEY AND A. B. BRADLEY. U. S. 1,411,158, Mar. 28, 1922. (*C. A.*)

63. Electric crucible furnace. C. H. CARPENTER. U. S. 1,409,669, Mar. 14, 1922. (*C. A.*)

64. Refractory cover for electric furnaces. M. S. CLAWSON. U. S. 1,410,654, Mar. 28, 1922. (*C. A.*)

Abrasives

65. Corundum Industry in the Northern Transvaal. A. L. HALL. *South African Jour. of Indus.*, **5**, 153(1922).—The Transvaal corundum fields extend over some 2000 sq. m. The keen competition in the industry has necessitated changed methods of recovery and grading. The principle of concentration of corundum from crushed reefs by mech. methods similar to those used in tin mines, has been thoroughly tested and in this way it has been demonstrated that superior grain corundum of marketable quantity can be economically produced in the Transvaal fields by methods much less elaborate than those in use at the famous Craigmount Mill in Canada, now burnt down. Crushing, concg., and grading are fully described with an accompanying "Flow Sheet." A wheel made of this grain corundum passed a severe test in London very satisfactorily. Since it is possible to produce well-graded commercial grain corundum of high quality economically, and to furnish abrasive material of great purity and high alumina percentage, the general outlook of this new industry in South Africa is distinctly encouraging. O. P. R. O.

Stoneware, Whiteware and Porcelain

66. The use of electrolytes in the purification and preparation of clays. H. G. SCHURECHT. *U. S. Bureau of Mines Tech. Paper*, **281**(1922).—The following subjects are covered: (1) relation of salt to clay in the purification of clays, (2) use of

H_2SO_4 in the sedimentation of clays, (3) effect of electrolytes when added to plastic bodies, and (4) effect of wet grinding, screening, electrolytes and dextrine on clays of low plasticity. H. G. S.

67. The grinding and preparation of raw materials in the whiteware industry. B. WILDE. *Keram. Rundschau*, **30**, 167, 168(1922).—With the substitution of machinery made for handmade ware, the proper preparation of the bodies becomes more important. The grinding mills should be set up in a clean, well lighted place and the floor of the grinding room should be of cement or tile with sufficient grade to allow them to be easily cleaned and drained. Extreme cleanliness is necessary in the grinding room, the mills should be cleaned every evening and no one should be permitted to enter with soiled shoes. The room should be well heated and lighted in the winter to allow the men to work more efficiently. Drops of oil from machinery should not be allowed to enter the clay since these contain iron which would discolor the ware. The blunger and agitators should be covered. As much as possible of the equipment should be made of wood instead of iron. Before mixing water with the clay the latter should be thoroughly dry since wet clays do not mix as easily as dry clays. H. G. SCHURECHT

68. Manufacture of culinary ware. F. BIGOT. *Rev. Mat. Constr. Trav. Pub.*, **151**, 53B–54B, **152**, 68B–71B (1922).—The making of culinary ware from clays found at Vallauris, Switzerland. Chemical analyses of the clays found at different depths are given. LOUIS NAVIAS

69. Proper design of porcelain insulators. J. F. SCHEID AND W. WEICKER. *Elektrotechn. Z.*, **43**, 564–5(1922). C. G. F. (*C. A.*)

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70. Molding earthenware, etc. W. A. VAN DIJK. Brit. 174,918, Jan. 16, 1922. Earthenware, etc., is molded by introducing the prepd. liquid material into a rotating mold having recesses corresponding in shape to the required articles, the material being forced into the recesses by centrifugal force. Exterior projecting wall portions may replace the recesses, and cores for hollow articles may be provided. (*C. A.*)

Art and Design

71. The use of secondary reference standards in process problems of color measurement. H. S. BUSBY. *Amer. Soc. Test. Mat.*, **21** (1921).—A discussion covering the fundamentals and practical problems involved in setting up an effective textile color lab., for routine color testing of the material of regular process problems. Application and discussions. F. H. R.

PATENTS

72. Plating on porcelain or glass. S. YUNOKI and Y. NAKAZAWA. Jap. 38,689, May 21, 1921. Lavender oil or an aq. soln. of Ag_2O is painted on porcelain or glass and heated at about 600° in a muffle furnace, whereby Ag_2O is fused on the surface which is further plated by a suitable method. When the m. p. of the material is not high, a mixt. of 1 pt. Ag_2O and 0.1 pt. solvent, made of 1 pt. minium, 2.2 pts. borax and 0.5 pt. Bi oxide, is used instead of Ag_2O and heated at about 380°. (*C. A.*)

Heavy Clay Products

73. Building tile from slag. ANON. *Contract Record*, **63**, 361(1922).—The National Slag Products Ltd. was incorporated in July, 1921, under Dominion Charter for the purpose of mfg. hollow building tile from granulated blast furnace slag, a waste material secured by long term contract from the Steel Company of Canada, Hamilton, Ont. Capital $300,000. The plant is situated at Hamilton and production was to have started May 1, 1922. O. P. R. O.

74. The making of clay brick. CH. BRAILLION. *Rev. Mat. Constr. Trav. Pub.*, **152,** 74B (1922).—B. refutes the assertion that lime-silica brick can not be made with argillaceous sands. Sands containing up to 20 per cent clay were mixed with slaked lime, and made into good brick, without any difficulty. A mixture of pure clay and lime gave a resistant product. Special precautions have to be taken when pure sand and clay are used with the lime. LOUIS NAVIAS

75. A new building material. ANON. *Raw Materials Review* (London), **1,** 54 (1922).—Paul Atterfelt, of Gothenburg, Sweden, has contrived a new building material made of a compn. of wood fibre, by which complete buildings, walls, etc., of any kind may be made. While one cu. m. of brick costs 144 kronen finished today, the cost of the new material would only be 35 kronen. It is particularly easy to work, and can be sawed and planed. It has a large bearing surface, and has almost double the heat-insulating value of wood. O. P. R. O.

76. Treatment of silicates for alkaline sulfates. (A process by E. Levitt, of Montreal, Canada). ANON. *Raw Materials Rev.* (London), **1,** 54(1922).—According to this specification, silicates such as potassium-bearing silicates and clays are fused with boron trioxide or any substance that yields boron trioxide at a high temperature, and then treated with sulfur dioxide. Bisulfites of the metals present pass into soln., while silica remains undissolved and is filtered. The filtrate is boiled, sulfur dioxide is evolved, the bisulfates converted to sulfites, and aluminium pptd. as hydroxide. The ppt. is then filtered, and the filter boiled, thus dioxidizing with access of air the sulfites to sulfates. O. P. R. O.

Glass

77. Recuperative glass furnace. ANON. *Glass Worker*, **41,** No. 34, 11(1922).—The new Chapman-Stein furnace is described. Increased capacity, longer life of pots, reduced fuel consumption and better temp. control is claimed. R. J. M.

78. Some aspects of science applied to the glass industry. C. H. KERR. *Glass Industry*, **3,** 69–71(1922). J. B. PATCH (*C. A.*).

79. The production and properties of optical glass. F. WEIDERT. *Glashütte*, **51,** 774–5, 787–90, 803–5, 819–21(1921); **52,** 1–3, 17–18(1922), 9 illus.—See *Ceram. Abs.* **1,** 116 (1922). J. B. PATCH (*C. A.*)

80. Specifications for lime-flint glass tumblers. ANON. Bur. Standards, *Circ.*, No. **119,** 1–3(1922). G. E. BARTON (*C. A.*)

81. Pyrex: a triumph for chemical research in industry. W. H. CURTISS. *J. Ind. Eng. Chem.*, **14,** 336–7(1922). J. B. PATCH (*C. A.*)

82. A radiation electric glass furnace. V. M. SAUVAGEON. *Chimie et industrie*, **7,** 452–5(1922).—Outline of the expts. carried out by S. from 1908 to 1914. The first furnace, heated entirely by passing the current through the charge, was not satisfactory because the heat was too concd. and caused rapid wear of the pot, while the passing of the current through the glass prevented obtaining a flawless product. In the next furnace, a heating element was placed in the roof of the furnace and the current was also passed through the charge, and finally all the heating elements were placed in the roof and the walls and no current was passed through the charge. In this last furnace the lower portion, built of refractory materials, comprised a seat for the melting pot, raised in such a manner that natural ventilation could take place under the floor supporting the pot. The walls and roof were of MgO, contg. at least 7% Fe oxide. There were 3 chambers, each contg. a resistor of fine-grained petroleum coke (which became graphitized when the furnace started up), and the electrodes passed through the ends of the furnace. Above each chamber is an opening which allows the inspection of the resistor, even when the furnace is running, and by means of which the coke is renewed.

The roof and walls were purposely made quite thick. Single phase a.c. was used. The furnace was run from June 11 to July 18, 1914, when it had to be shut down through wearing out of the pot. The roof and walls were taken down for inspection and were seen to be in excellent condition. The tests showed: The furnace is of sturdy construction, easily inspected, even when running, and simple to control. It can be started up directly. Interruption of the current involves no drawbacks other than stopping of production during the time the current is off and the time required for bringing the furnace back to its working temp. It is perfectly safe, as there is no current passing through the working part of the furnace. There is no deterioration or transformation of the charge. Temps. all the way up to 1,425° can be obtained and maintained very closely. The roof was constructed too thick. Reduction of the thickness would allow of higher temp. and better yield per kw. Good quality glass can be manufd., and with some minor changes the furnace is suitable for com. operations. Owing to high and const. temp., better and more resistant glasses can be obtained, and more particularly SiO_2 glasses with a high insulating power. The tests are being continued.

A. P.-C. (*C. A.*)

PATENTS

83. Glass. W. C. Taylor and H. P. Gage. U. S. 1,411,133, Mar. 28. A glass opaque to visible light in plates 6 mm. or more in thickness is formed by the addition of MnO_2 6% and Cr_2O_3 0.5% ($K_2Cr_2O_7$ 1%) to a SiO_2 46, PbO 33 and K_2O 14 part glass. U. S. 1,411,134 relates to production of similar glasses. (*C. A.*)

84. Care of glass melting pots. H. W. Hess. *Glass Worker*, **41**, No. 29, 14, 22, 24(1922).—In heating the pots in the pot arch uniformity of temp. is of greater importance than the length of time consumed in reaching the max. temp. of 2100–2200° F. The moisture is driven off at 230° F., and the greatest loss in wt. occurs between 900° and 1200° F. J. B. Patch (*C. A.*)

85. The action of iron and other metals upon clay and glass. H. W. Hess. *Glass Worker*, **41**, No. 27, 12, 36(1922).—When introduced with the batch pieces of Fe, Cu, brass and Pb have little or no effect upon the pot itself. If the metal is introduced after the metal is planed decided erosion takes place upon the refractory container.

J. B. Patch (*C. A.*)

86. Control of pot furnace conditions. H. W. Hess. *Glass Worker*, **41**, No. 32, 11, 29, 30(1922).—The essential uniformity of heating can only be obtained by intelligent pyrometric control. J. B. Patch (*C. A.*)

87. Magnetic separation in glass plants. R. A. Manegold. *Glass Worker*, **41**, No. 30, 11, 29(1922).—The magnetic separator is useful in removing tramp Fe from cullet and in reducing the Fe content of sand. J. B. Patch (*C. A.*)

88. Unbreakable glass? Anon. *Fachgenosse*, **38**, 39–40(1922).—The new glass, Silex, made by Horak, is composed of 98% quartz. Its coeff. of expansion is so small that beakers and flasks with 1-mm. walls withstand abrupt temp. changes of 400°. The glass is also very resistant to severe shock tests although not unbreakable. The color is described as smoky yellow; the color is due to the action of S_2 in the fuel. Silex is expected to replace metal and enamelled cooking utensils. J. B. Patch (*C. A.*)

89. Determination of the surface of glass powder. Hans Wolff. *Z. angew. Chem.*, **35**, 138–40(1922).—A soln. of 290 g. Na_2CO_3, 10 H_2O and 50 g. NaOH, pure and especially free from iron, was placed in a silver vessel heated on a water bath to 95°, and allowed to act (*a*) for 2 hrs. on glass plates of known sizes held in clamps, and (*b*) for ½ hr. on carefully sieved and washed glass powder of the same compd. as the plates, and agitated by stirrers of special form driven at 300 and 400 revolutions per min., resp. Loss in wt. of plates and powder was detd., calcd. to loss for 2 hrs., and the surface of the powder then computed from the equation: surface of powder/surface

of plates = loss in wt. of powder/loss in wt. of plates. For purposes of comparison such results were then reduced to "surface per gram" and "surface per cc." It was found that plates must be of the same kind of glass as the powder to be examd., and that the ways different kinds of glass splinter vary widely. Values for the surface of the same glass vary about 5–6% from the mean, and those for different kinds of glass by 20–30%. Expts. were carried on with 3 kinds of Jena glass, a window glass and glass for photographic plates, the Jena glass showing relatively smaller areas per g. and per cc. (and also lower hardness) than the other varieties. W. C. EBAUGH (*C. A.*)

90. Heat distribution in the glass factory. ANON. *Nat. Glass Budget*, **37**, No. 50, 8–9(1922).—The Denk Engineering Co. gives the following heat balance of producer gas as typical for glass furnace conditions: 20% of the total heat value of the fuel is lost in the producer, 5% in the gas line, 4% in the chamber, 32% in the furnace and 26% in the stack. The useful heat consumed by the glass is thus 13%. Proper insulation and clean gas are recommended to reduce the losses. J. B. PATCH (*C. A.*)

91. Annealing and the mechanical properties of glass. TAFFIN. *Compt. rend.*, **174**, 159–62(1922); cf. *Ceram. Abs.*, **1**, 216(1922).—Using the mathematical expression developed in a previous paper T. dets. the effect of forces applied to prisms of glass on the birefringence of the glass. The force necessary to cause a continuous deformation of glass at 410° corresponds to the value that may be obtained from the mathematical expression. Conclusion: The annealing of glass is a viscous deformation due to internal forces. L. H. RYERSON (*C. A.*)

92. Determination of sulfate-, chloride-, and carbonate-ions in soda-lime glass. MASAO IKAWA. *J. Chem. Soc. Japan*, **42**, 768–85(1921).—I.'s new method is based on the use of NH_4FHF to dissolve the glass instead of HF. Since the com. fluoride contains $PbSO_4$, PbF_2, NaF, Na_2SO_4 and Fe as non-volatile impurities, and NH_4 salts of H_2SO_4, HCl, H_2SiF_6 as volatile impurities and sometimes free H_2SO_4 and $(NH_4)_2SO_3$, a special method of purification is necessary according to the ion to be detd. SO_4-free fluoride is prepd. as follows: Into a hard glass flask 3 l. capacity (need not be Pb flask), about 400 g. of silicate powder (or common glass powder) mixed well with 200 g. of NH_4FHF are placed, and treated gradually with com. H_2SO_4. The resulting SiF_4 is led into 2 l. of H_2O in which H_2SiF_6 is formed (the clogging of the end of the tube by H_2SiO_3 is prevented by a little Hg placed in the flask). After the H_2SiO_3 is filtered off, the H_2SiF_6 is first neutralized with NH_4OH, and then decompd. by adding a large excess of NH_4OH. The clear filtrate is transferred to a Pt dish. NH_3 is driven off, and on cooling NH_4FHF crystallizes out. The crystals, after being freed from H_2O as much as possible, are purified by sublimation. The product is free from SO_4. The powd. glass to be analyzed is decompd. with about 9 g. of the purified NH_4FHF. If the fluid is neutral or alk. to litmus, more fluoride should be added. The resulting residue is dissolved in a small amt. of warm H_2O (the small insol. residue is CaF_2). The filtrate from the CaF_2 is neutralized with SO_4-free Na_2CO_3, and heated, filtered, and the residue washed 3 times on filter paper with dil. alc. (1:1). The filtrate is concd. to approx. ½, acidified with excess of $H_2C_2O_4$ and heated. The filtrate from the $H_2C_2O_4$ is evapd. to dryness and the excess $H_2C_2O_4$ destroyed by gentle ignition. The residue is dissolved in dil. HCl, filtered and the SO_4 detd. by $BaCl_2$ as usual. For Cl detn., the com. fluoride is freed from Cl by $AgNO_3$. The filtrate is treated with NH_4OH, and again filtered. From the filtrate, NH_4FHF is crystd. by concn. and cooling, and purified by sublimation. About 5 g. of the sample glass should be used for a Cl detn. For CO_2 detn., the crude fluoride is dissolved in H_2O, and treated with NH_4OH. The filtrate is evapd. in a Pt dish to drive off NH_3. The residue is recrystd. Then about 15–20 g. of glass powder is decompd. by the fluoride and CO_2 is detd. by a slight modification of Fresenius-Classen's method. The results of analyses of various im-

ported window glasses show that SO_4 (as Na_2SO_4) varies from 0.667 to 1.045%, non-sulfate S (as Na_2SO_4) from 0 to 0.108%; Cl as NaCl from 0.066 to 0.154%; and CO_2 as Na_2CO_3 from 0.021 to 0.055%. S. T. (*C. A.*)

93. The action of metallic lead in pots. HENRY W. HESS. *Glass Worker*, **41**, No. 28, 14, 22(1922).—Six duplicate tests using finely divided Pb in place of litharge yielded a first class glass and the pot bottom showed no ill effects. The Pb button sometimes found on pot bottoms is believed to be harmless, at least as far as chem. action on the pot is concerned. J. B. PATCH (*C. A.*)

PATENT

94. Means for feeding goods into and removing goods from annealing and other furnaces. MARTIN VAN MARLE. England, 1,402,551, Jan. 3, 1922. Apparatus for charging or discharging furnaces, comprising (1) a traveler adapted to move transversely, (2) a cross frame carried by the traveler having rails, (3) a goods carrying carriage mounted on the cross frame and adapted to move on the rails, (4) longitudinally disposed goods-carrying bars movably mounted above the carriage and adapted to carry the goods into or remove them from the furnace (5) means for raising and lowering the bars on the goods carriage, (6) means for moving the carriage longitudinally to carry the goods bodily into the furnace. C. M. SAEGER, JR.

Cement, Lime and Plaster

95. Cement industry. Punjab, India. ANON. *Jour. Royal Soc. of Arts*, **70**, 505.—It has been said that the measure of a country's prosperity may be gauged in these days of industrial progress by the extent of its cement interest. The recent industrial awakening of India has gererally synchronized with the development of the manuf. of Portland cement in various ports of the Peninsula. The Governor is to possess a cement factory of his own. The site for the plant is Wah, in an area of an almost inexhaustible supply of limestone and clay of admirable quality for the manuf. of first-class Portland cement. Abundant supply of clear cold water from the Himalayas is available here. The whole of the plant will be driven elec. by a steam-driven turbogenerator of 1,500 kw.—probably the most modern unit of its type in the Punjab. O. P. R. O.

96. Gypsum in British Columbia. A. G. BANGLEY. *Ann. Rept. B. C. Minister of Mines*, G. **129**(1921).—A deposit of gypsum occurs along the North Bank of the Bull River in the Eastern District of B. C. at a distance of about three miles from the main road to Fort Steele and within a short distance of the falls and the Kootenay Central Railway. The deposit has considerable overburden but shallow diggings have uncovered the mineral, and from all indications there is a large deposit conforming to the dip and strike of the formation. The analysis of a representative sample gave the following results: Gypsum, 80.5; carbonate of lime, 14.4; insoluble, 3.5; magnesium oxide, 0.6; organic matter, 0.8. Another large deposit of gypsum has been opened near the railway at Kelly Lake in the Lillooet District. O. P. R. O.

97. Standard specifications for Portland cement. ANON. *Canadian Eng. Standards Assoc.*, (1922).—The specification is based on the recommendation of the Engineering Institute of Canada, but agrees substantially with the Tentative American Standard Specification, while certain clauses have been adopted from the British Standards Specification. It takes into account the most modern developments of cement manuf. testing and use, both on this continent and Europe. Chem. properties, phys. properties, packing and marking, inspection and rejection of cement are outlined. This specification differs from the American and British Standards in cases where Canadian conditions require distinctive treatment. O. P. R. O.

98. New methods for proportioning concrete. R. B. YOUNG AND T. V. MCCARTHY. *Canadian Engineer*, **9**, 263–65.—Basis of the new theory is the idea of proportioning concrete to develop desired minimum strength in a specific time. Four classes of concrete have been established by the Hydro-Electric Power Commission, each to develop stipulated strength at the age of 28 days: (1) Class A, 2,500 lb. per sq. in. (2) Class B, 2,000 lb. per sq. in. (3) Class C, 1,500 lbs. per sq. in. (4) Class D, 1,000 lb. per sq. in. These correspond roughly with the common proportions 1:1½:3, 1:2:4, 1:2½:5, and 1:3:6. This plan is much more logical than specifying a set of mixts. because, for example a 1:2:4 mix may under certain conditions give a strength as low as 500 lbs. per sq. in., and under more favorable conditions a strength of 4,000 lbs. per sq. in. To the man in the field consistency is a more important feature than strength. Nevertheless he controls to a great extent, the strength of the resulting concrete by making the consistency conform to an adopted standard. The Hydro-Electric Power Commission has attempted to proportion concrete, not only for a given strength but for a given consistency. This was impossible by the former methods of proportioning and mixing but the development of this new method makes a stated strength and a stated consistency possible. The Commission has also used the water-cement-ratio strength relationship, changing the ratio to correspond to weights rather than to volumes, in order to facilitate the work of proportioning. The Commission has chosen the conditions under which the minimum variations occur and has found the theory most successful. A standard consistency has been arrived at by trial and the quantities of water necessary to produce this consistency have been determined for various mixes. The denser the concrete the greater its strength. It is possible to predict within a few hundred pounds the possible strength of concrete proportioned by the new method. O. P. R. O.

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a triaxial diagram having G, M and F sizes (Q. V.) as apices, and curves of compression strengths of 310, 300, 250, 200, 150 and 100 kgs. per sq. cm. drawn on it. The mortar was that of 1 part cement and 3 parts quartzite. The maximum strength was obtained with a mixture of 5:1 of sizes G:F. The strength decreased very rapidly towards G and only slowly towards F and M. LOUIS NAVIAS

100. Sand-lime brick and sand-lime mortar. R. P. BROWN. *Rock Products*, **25,** No. 6, 36–7(1922).—Sand-lime brick contain approx. 10% by wt. or 25% by vol., of hydrated lime. If sand and lime mortar contg. 1 pt. of lime to 3 of sand be used for setting sandlime brick the structure will be practically monolithic and therefore of max. strength. The smooth working qualities of sand and lime mortar make even bedding of bricks easy. The mortar has a strength of 1622 lbs. per in.^{2} on an av. or 16 times the allowed safe load. It is also more adhesive than cement mortar. The crushing strength of cement mortar (1:3) was increased by 10% by substituting lime for half the cement. Ten % of lime added to cement mortar increased its adhesiveness (to bricks) by 130%. Bricklayers can lay 30 to 50% more brick per day in lime mortar.
J. O. H. (*C. A.*)

101. Lime burning in the rotary kiln. A. E. TRUESDELL. *Rock Products*, **25,** 24–30(1922).—A brief historical review of the art is followed by consideration of the main facts on which efficient plant design must be based. The rotary kiln handles spalls and other fine sizes most efficiently. Dust must not be used and fuel consumption is high if stone larger than 1½″ is used. Uniform burning and high output require close sizing and fine stone; 10% less fuel was used for ⅛″ than for ¾″ stone. Kilns are 6 to 8 ft. outside diam. and 100 to 125 ft. long. They are lined with fire brick, or with silica brick for the lower 20 ft. if sizes above 1 in. are to be burned. The former only last about 5 months at that part while the latter stand twice as long if set so as to permit expansion. The kiln is set at 4 to 5% slope and is rotated at ⅛ to 1 r. p. m. as required. Magnesian limestone burns faster and may be used in larger sizes or put through faster with less fuel. Gas or oil fuel is best. Powd. coal unless very low in ash contaminates the lime. Producer gas should be of uniformly high grade and well mixed by introducing it under preheated air from the cooler. The latter should be from 30 to 50 ft. long by 4 or 5 ft. in diam. Feeding of the stone from an elevated bin is automatic as the kiln runs. A dust chamber is located between the kiln and the stack. A waste-heat boiler with proper facilities for dust removal is desirable. Operating cost with an 8×125′ kiln, heated with producer gas, electrically driven and turning out 60 to 75 tons of lime each 24 hrs. for 300 days per year may vary from $3.45 to $8.47 per ton of lime made. The lower figure is based on 12 hr. shifts and 30c. per hr. wage, the higher on 8 hr. shifts and 50c. wage. Magnesian stone, coal at $5.00 per ton (4½ lbs. lime per lb. coal), power 1c. per kw.-hr. and $9.00 less per day for repairs and fixed charges are the basis of the lower cost figure. $90,000 to $100,000 plant investment is required. Rotary kiln lime burning needs further fuel-saving devices.
J. O. HANDY (*C. A.*)

102. Sound-proof partitions. F. R. WATSON. Univ. Ill. Eng. Expt. Sta., *Bull.*, **127,** 78 pp. (1922).—A compilation of available information on methods for insulating sound, with special reference to the needs of architects and builders.
H. L. OLIN (*C. A.*)

BULLETIN
of the
American Ceramic Society

A Monthly Publication Devoted to Proceedings
of the Society, Discussions of Plant Problems, Discussions
of Technical and Scientific Questions and
Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

F. H. Rhead, M. C. Farren, B. T. Sweely, R. R. Danielson — Art, Enamel
J. C. Hostetter, A. E. Williams, J. S. McDowell, F. A. Harvey, F. K. Pence, C. C. Treischel — Glass, Refractories, White Wares
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EDITORIALS

THE VALUE OF THE ABSTRACT SERVICE

Rendered by

The American Ceramic Society

The American Chemical Society has ten times (about 17,000) as many members as has this Society and the very large majority of these members pay $15.00 a year membership subscription, more because of the service rendered by that Society in abstracting the worlds' literature on general and applied physics and chemistry than because of any other service. In order to render this service of abstracting their Society must maintain a virile, progressive organization, promoting and discovering facilities for research. To retain this position of authority it is absolutely essential to hold conventions, to maintain Industrial Divisions, to establish and to invigorate local sections, to be engaged in the compilation of monographs, etc., and in many other ways to promote and facilitate research. Whereas publishing abstracts of the worlds' current literature is but one of the many activities made possible by the organized coöperation of so many, it is the one service that is considered by most of the members as being worth more than their membership subscription.

The American Ceramic Society is engaged in this same sort of work but limiting its activities to the promotion of ceramic research. There is in this Society as in the Chemical Society that same need of well-organized

activities to make possible the publication of original literature and the abstracting of ceramic literature. This Society is obligated to its larger sister organization for an exchange of facilities for abstracting, an exchange which has been far from balanced, the Chemical Society rendering the much larger service. It nevertheless is true that as the American Ceramic Society has grown in strength and has increased its activities, the abstractors have increased their output until now the exchange between the two Societies is about 50–50.

Now as to the value of this service. We have repeatedly said that it was worth more to corporations than the total fees paid by them as corporations and for personal memberships of their employees. Here is concrete evidence: One person mailed 900 cards to this office each card showing an abstract of a published article. The package was insured for $2000. In a letter the member said that $2000 would not measure the loss he would sustain if they should not be returned.

Many corporations employ abstractors and go to the expense of printing and distributing among their employees those abstracts that are of direct value in their work.

These citations show that the monetary value of abstracts exceeds many times the membership fees paid to a Society that is sufficiently well organized and activated as to produce and publish each month an average of 135 to 150 abstracts. This is but a single part of what the members of this Society are receiving for the small membership fee of $7.50 for personal and $25.00 for corporations.

THE "WHAT FOR" OF THE AMERICAN CERAMIC SOCIETY

Does It Conflict with Trade Associations

A little while ago a prominent manufacturer asked if the Trade Association, of which he is an officer, was not engaged in the same work as the American Ceramic Society.

The first answer was Yes, in part.

One of the Industrial Divisions is working on the same problems as is his particular Trade Association with this difference—the Industrial Divisions of the American Ceramic Society bring together on one program of activities representatives of all the research agencies, collegiate, federal, state and industrial, with the trade associations and users of ceramic products.

The second answer was No.

In the first place, each Industrial Division of the Society is coöperating and coördinating with all industrial ceramic groups, each Division well organized and each working not only on its own distinctive and special problems but also on the many problems that are of common interest.

In the second place, the Society publishes monthly the results of investigations made in the several laboratories, and also discussions on plant problems, an undertaking which is quite foreign to the scope of trade associations.

In the third place, the Society publishes each month an abstract review of the worlds' literature of interest to ceramists. This service to the technical men employed in plants and by trade associations is alone worth all the financial support required to maintain the activities of this Society.

Then, in the fourth place, the Society is especially organized and equipped for the task of coördinating ceramic research activities of all ceramic groups in the technology and science of ceramics and for the publishing of the findings made in each of the researches. The trade associations are organized and equipped especially to secure and maintain cooperation of a group of manufacturers of the same sort of product on such problems as trade, traffic, tariff and accounting—the business problems. The technical organization would make a poor shift with the business problems, and, without the coöperation of a scientific organization the trade associations would make a poor shift with research in the technical and scientific problems. It is necessary that trade associations employ the personnel and facilities of a technical and scientific research organization, such as are found in the federal bureaus and in collegiate institutions.

It is absolutely sound economically that trade associations be engaged in technical and scientific researches in coöperation with the federal bureaus and the colleges. It is absolutely essential too, that each trade association maintain a "Technical Research Committee." The economies of such organized technical research activities are principally twofold: (1) the industrial executives learn the need and value of technical research, thus assuring plant application of the findings, and (2) each trade group confines its researches to problems of immediate manufacturing concern to that group.

Where does the American Ceramic Society come in as an essential in this program of research other than as a central publishing agency, owned and controlled jointly by all the ceramic groups?

Here is the answer: There are many agencies now working in ceramic science and art; but except for their contacts through the American Ceramic Society, these several agencies are without any attempt at coordinating their activities, or the results of their undertakings. Without the American Ceramic Society in which the research organizations and the manufacturing groups have a common interest and responsibility, there would be wastage and duplication of efforts and their would be no gleaning and publishing of the worlds' knowledge in ceramic science and technology. This is often spoken of collectively as the educational enterprise of the Society.

It is fairly certain that there are many problems deserving attention which are not receiving the attention of the research committees of the trade associations. There are fundamental problems of which universities could most effectively be engaged but to which their attention would not be drawn except through close contact with the industrial representatives in the Society. No trade association or research organization can undertake at one time more than a limited number and scope of research activities whereas each manufacturer has many urgent problems on which coöperation with other manufacturers or other agencies is valuable if not vital.

It is certain that there is value in coördination in technical research by the several ceramic groups, which groups, though diversified, have many problems in common. There are many manufacturing problems deserving attention which are not being studied in systematic coöperation. It is the function of the committees of the American Ceramic Society not only to bring these to the attention of competent research agencies but to follow through the solving of them, bringing to their solution the very best minds and knowledge.

The largest and most important functions of the American Ceramic Society are (1) to establish and maintain the mechanisms by which the several research agencies and the several industrial groups may have coördination and coöperation, not two by two, but all together, the ceramic crafts and ceramic laboratories jointly; and (2) to establish (in the words of Dr. Angell) "assurance of both continuity and community of programs, prompt interchange of findings, especially for purposes of educational training, expert assistance, and, in general, the services of a central body, intelligently in touch with a great variety of undertakings, all of which converge upon the fundamental problems" of all ceramic industries.

This Society does not duplicate the work of trade associations in technical research, for the part taken by the Society in such enterprises differs radically from that of the trade associations. Time has gone when a single manufacturing concern can afford to carry on research in isolation; contact must be had with other concerns through persons or organizations. By the same tokens we recognize that trade associations, universities and federal bureaus can not successfully work in isolation on technical and scientific problems in ceramic manufacturing. There is a need (becoming more and more felt) for a central clearing organization.

The field for and scope of the activities of the American Ceramic Society is clearly defined. It will not engage on problems other than technical and scientific. It will not finance nor be directly interested in the financing of research work. It is an institution organized especially to assist all ceramic research agencies, at no time nor under any circumstances assuming a dictatorial prerogative but ready to direct when called upon, serving most essentially as a general coördinating agency for all of the specialized ceramic

research agencies and industrial groups, and an educational institution alike for the technologist, the scientist and the plant operator.

The Society does not duplicate nor conflict with trade associations in technical research activities; the interests of each are supplementary.

CHEMICAL EXPOSITION SPEAKERS

EXPOSITION OF CHEMICAL INDUSTRIES, GRAND CENTRAL PALACE, NEW YORK

That portion of the program for the Eighth National Exposition of Chemical Industries which will be held during the week of September 11–16th at the Grand Central Palace, New York, that has been definitely arranged, contains the names of a number of well-known speakers. Herbert Hoover, Secretary of Commerce, and frequently referred to as "the business man of the Cabinet," will speak on the subject:—"Standardization and What It Can Do for the Chemical Industry."

Other addresses thus far scheduled on the partially arranged program of the 1922 Chemical Exposition, include a number of particular interest to the ceramic industry of the United States. The Standardization Program, to which one whole afternoon session of the program will be given, will include the following speakers: W. D. Collins of the United States Geological Survey on "Moderation in Standardization;" N. F. Harriman of the United States Bureau of Standards on "Standardized Testing Apparatus;" I. G. Jennings, general representative of the Glass Container Association on "A Discussion of the Reasons for the Varieties of Shapes and Sizes;" J. M. Roberts, Secretary of the Apparatus Manufacturers Association of the United States, on "What Has Been Accomplished in the Standardization of Scientific Apparatus;" Ross C. Purdy, Secretary of the American Ceramic Society, and Chairman of the Committee C–8 on Refractories of the American Society for Testing Materials, on "Standardization of Fire Clays and Refractories;" Emerson P. Poste of Elyria Enameled Products Co., on "Standardization of Enameled Ware for Chemical Industries."

Speakers for other groups of chemical and allied associations will take part in these programs.

Other afternoon technical and business sessions will be under the direction of the American Ceramic Society, the Association of Synthetic Organic Chemical Manufacturers of the United States, the Technical Photographic and Microscopical Society, and the Salesman's Association of the American Chemical Industry, the time for which meetings has not as yet been set. All sessions will be held in the special Grand Central Palace Auditorium. The motion picture program which will be held in the evenings exclusively, now has on it the following: "The Story of Asbestos," four reels, by courtesy of the United States Bureau of Mines and the

Johns-Manville Co.; "Preparation of Nickel and Securing Copper as a By-product," four reels, by courtesy of the International Nickel Co. accompanied by discussion; "The Romance of Cotton," one reel, accompanied by discussion by Dr. David Wesson; "Prospecting for Gold in Northern Ontario," two reels; "Assaying for Gold in Northern Ontario," one reel; both courtesy of the Ontario Department of Mines. Numerous other details of the Exposition program have been arranged tentatively and as soon as definite confirmation can be obtained, they will be announced.

THE ITALIAN MAJOLICA PROCESS AND PAINTING OVER TIN ENAMELS[1]

By Frederick H. Rhead

ABSTRACT

Reference is made to historical types. Practical conditions are discussed, types of glazes are given, and methods of application are outlined. There are also comments in connection with one-fire products.

The processes involved are discussions A-3 and A-4: "The Italian Majolica Process," "Painting over Tin Enamels," are so closely related that they are taken together.

General Outline of the Processes.—Conditions at hand, and the particular style of decoration then prevalent, determine the type of pottery made by any particular country. The Chinese happened to find unlimited supplies of kaolin, and so produced porcelains. The Italians and Persians used the available red and buff faience clays, and in order to obtain white and light colored grounds, developed opaque tin enamels and applied their decorations over these.

Sometimes the ware was glazed all over with opaque white enamel and the decoration applied over this; or a color palette, with the white enamel as a base, was prepared, and the colored glazes were painted over a modeled surface. The Della Robbia wares were executed in this manner.

Painting over Tin Enamels.—This process is much like that of underglaze painting on the bisque except that instead of painting over a biscuit surface with calcined metallic stains, the decorator uses similar stains but applies these over an unfired glaze ground. Where more brilliancy is required, a thin coat of transparent glossy or mirror glaze is sprayed over the decoration which is consequently sandwiched between an enamel and a shiny glaze. But more often, especially in the case of the Italian wares, the usual method is to simply paint over the unfired enamel and then to fire the ware to a temperature that will fuse the colors into the enamel which develops a semi-mat or smooth texture.

The Italian and Persian wares were mostly one-fire products, although it is possible that occasionally the clay ware was given a soft bisque fire to strengthen it for the glazing and decorating processes.

The Order of the Processes:

1. The ware is made of a red or buff terra cotta body and dried.
2. The ware is dipped or brushed with a level and smooth coat of the opaque tin enamel.
3. The design is drawn or stenciled over the shape and the decoration applied in the manner described in the paper on underglaze painting.[2]

[1] Discussion prepared for the Art Division of the American Ceramic Society, Twenty-fourth Annual Convention, St. Louis, 1922.

[2] F. H. Rhead, *Jour. Amer. Ceram. Soc.*, **5**, 376 (1922).

4. The ware is ready for the firing process unless a thin application of the transparent glaze is desired.

Condition of Ware to be Glazed.—Either clay or biscuit ware may be glazed with the opaque enamel. If the glazing is done in the clay state, the ware must be almost or quite dry. Any clay which will not disintegrate, blister or crack when the glaze is applied may be used. The process of glazing fragile wares is obviously a delicate one, and, where quantity production is concerned, it is a question if the loss incurred in broken clay ware does not set aside any advantages or economies derived by the elimination of the bisque fire. Personally, I like the one-fire process because I get much better surfaces and textures when the body and glaze are developed to maturity together. But this is entirely a matter of local conditions. Most of the early art and faience wares, together with some of the finest porcelains, were entirely one-fire productions, and at the present time much of the European faience and art wares (I do not refer to table and utilitarian wares) are made in one fire.

There are a number of concerns in this country also making one-fire products. I have had five years practical experience in California making ornamental wares and tile. The production averaged about one thousand pieces per week, and over ninety per cent of this was finished in one fire although the ware was very carefully made and often highly finished and expensively decorated.

Enamels, mates, underglaze decorations, lustres, and mirror glazes were used in the production of these wares. In fact, about the only practical reason a bisque firing is adopted is because it has been found practical and economical for the large production of the more fragile wares, and because it makes possible the storage of unglazed stock without incurring large losses in broken wares.

While the tin enamel and majolica processes may be done in either one or two fires, it is advisable for the beginner or average studio potter to use two fires to eliminate the danger of breakage, which always accompanies inexperienced handling.

Methods of Glazing for Painting over Tin Enamels.—Any of the known methods are practical—dipping, spraying or brushing.

For commercial work, dipping is most convenient, although certain ornamental pieces require skillful treatment to obtain a thoroughly even coat of glaze over an upright or complicated surface. For elaborate decorative work, a brushed surface using a glaze containing a strong solution of gum tragacanth may be advisable. A number of painters doing individual work prefer to glaze their own pieces.

A coating of glaze averaging about one-sixteenth of an inch in thickness is required. As a rule, a glaze containing about ten per cent or more of tin oxide need not be so heavily applied. Glazes containing less tin

oxide, and those fired to higher temperatures than cone three or four, will require heavier applications. For tile and other flat surfaces, the glaze may be applied to a thickness of almost an eighth of an inch.

The tin enamels[1] are comparatively non-flowing glazes unless there is an extreme condition of overfiring; consequently the applied surface must be level and smooth.

Methods of Decoration.—For average work, the methods suggested[2] for underglaze painting on the biscuit will apply in this process. Any of the mediums except turpentine and fat oil may be used.

In the Italian processes, the design was usually sketched lightly over the glaze and afterwards outlined with cobalt blue, manganese, or an iron brown. Almost any of the colors used in the biscuit process are practical, although it may be advisable to eliminate greens containing chrome which usually flashes or fumes the tin glaze.

Either flat or painted treatments are possible. One has only to refer to examples of Italian wares in the various museums, and also to the skillfully painted Delft wares.

Some of the Italian works of the fifteenth and sixteenth centuries were enriched with lusters applied after the glazed firing.

There have been some examples of painting over tin enamels where the glazed ware was fired before the decoration was applied. A number of European potters have produced in this manner but this ware lacks the depth and brilliancy of decorations over the unfired glaze.

Besides the underglaze colors, or calcined stains, non-flowing colored glazes of various textures can be applied to the tin enamel ground, either alone or in combination with the underglaze colors. The Persians were very skillful in their manipulation of glazes over a glaze, or slip engobe over which would be applied a light coat of transparent glaze.

The Majolica Process.—One can obtain a fair idea of this process by contrasting it with the other processes under discussion. In painting over tin enamels the stains are applied over an unfired glaze. In underglaze painting on the biscuit, the stains are painted on the biscuit body and the ware afterwards glazed. In the inlay process, the glazes are applied on the clay or bisque within a raised, flat or sunken outline. In the majolica process, the colored palette consists of colored glazes, as in the inlay process, and these are applied over the modeled surface. No outline or boundary is used.

Assuming that the decoration consists of a modeled fruit border, a typical Italian motif, the palette will probably consist of two copper greens, uranium, iron, or antimony yellows, chrome tin pinks, cobalt blues, and manganese and iron browns.

[1] *Jour. Amer. Ceram. Soc.*, **5**, 259 (1922).

[2] *Ibid.*, **5**, 376 (1922).

A gum medium is used and the colors are applied directly to the clay or bisque surface. Certain details may be accentuated by means of stains, or colored glazes lighter or darker in tone, or of greater brilliancy.

In modern commercial practice, the term majolica was applied to any type of colored glaze painting, but in these notes the wares referred to are the Italian wares of the Della Robbia type.

Of course other types of glazes may be applied in the manner described. In this country quite fine faience and terra cotta wares are decorated with colored mats treated in the same manner as were the old tile enamels, and the effects are quite as interesting so far as harmonies and soft effects are concerned. But the average mat is a non-reflecting glaze, and lacks the brilliancy and lustrous quality of the enamel. The mat glaze is obviously a beautiful and valuable decorative medium, but it is only one of the many possibilities open to the ceramic artist and decorator.

AMERICAN ENCAUSTIC TILING CO.
ZANESVILLE, OHIO

DISCUSSION ON "THE TESTING OF SILICA BRICK"[1]

MR. GREAVES-WALKER:—I am sure the expression of this division is that we appreciate the visit of Dr. Endell and his arranging to be here at the time of our Ceramic meeting. Dr. Endell is, without doubt, the leading silica brick expert of Germany and we have in this room probably all of the experts of this country, or those we class as experts—I might mention Messrs. Harvey, McGee, McDowell and Howe—and out of those four we should certainly get some discussion on the recommendations that Dr. Endell has made in regard to silica refractories. The paper is open for discussion.

DR. HARVEY:—I have been exceedingly interested in this paper—it covers the same ground, of course, in which he and I have been working for three or four years. I would very much prefer to study this paper and write a discussion on it than to attempt to discuss it finally at this time. I do not believe it is necessary to specify both gravity and linear expansion. I think if you have specified one you have covered both.

Another thing that struck me is that Dr. Endell takes one hour and a half to heat silica brick from room temperature to about 1600°C. It is our experience that if you heat silica brick as rapidly as that, you would get excessive expansion and develop cracks; linear expansion measured by that method, in our experience, is more the function of the temperature change than the degree of the conversion of the quartz.

The third fact that occurred to me is that the method which Dr. Endell uses for determining the percentages of cristobalite and tridymite seems to

[1] K. Endell, *Jour. Amer. Ceram. Soc.*, **5**, 209 (1922).

give very much higher values than we have in American brick. Therefore, as I state, before I could discuss that I would like to study the paper first.[1]

MR. ROSS:—In Dr. Endell's remarks yesterday he stated that some of the German quartzites are made of a large percentage of rather finely crystallized material which transforms more rapidly when given heat treatment than do our quartzites. That might answer Dr. Harvey's questions as to more tridymite and cristobalite.

MR. GREAVES-WALKER:—Dr. Harvey, I believe, referred to the fact that Dr. Endell got higher values in the examination of American brick than we have been able to get.

MR. MCDOWELL:—Dr. Endell's figures for American brick check rather closely those of Insley and Klein. I am not altogether sure just how closely they do agree. They are higher than the figures which I obtained about five years ago.

MR. GREAVES-WALKER:—I believe Dr. Endell obtained somewhere around 80% cristobalite in the American brick tested by him. Is that not extraordinarily high?

MR. MCDOWELL:—Perhaps Dr. Endell had Mr. Insley's figures in mind?

DR. ENDELL:—I think Insley found 75–80% cristobalite. I suppose Mr. McDowell sent to me only the best kind of American brick. In regard to our heating to 1600°C, I can say that most of our best silica bricks like the American silica bricks stand this heat treatment very well. I know there are several kinds of silica brick that do not stand this heating but the best kind do.

MR. MCDOWELL:—The brick sent Dr. Endell were commercial well-burned brick such as are now being made, and were possibly burned a little higher than was customary a number of years ago; this might have caused some difference in the microscopic analysis.

It should be borne in mind when comparing Dr. Endell's results with my own that my method is not capable of any great degree of quantitative precision. My figures were probably low, that is, the degree of inversion which I showed was probably somewhat less than the actual degree of inversion.

I doubt the practicability of specifying that silica brick shall have a definite content of the three forms of silica. Results are influenced by the method followed in making the determinations, and no method has yet been standardized. Not many petrographers have had sufficient experience in making examination of silica brick for their results to be of very great value.

DR. ENDELL:—I believe that the easiest method to determine the value of silica brick is through specific gravity.

MR. GREAVES-WALKER:—Dr. Endell, I believe the silica brick manu-

[1] *Jour. Amer. Ceram. Soc.*, **5**, 218 (1922).

facturers of this country are aware of the fact that they have to adopt two different standards, one for Baraboo quartzite and one for Medina quartzite. It is possible, under some conditions, to get as low specific gravity on Baraboo quartzite as on Medina quartzite, but perhaps the products made from Baraboo quartzite would be equal to those made from Medina even if there was a difference of 0.04 in the specific gravity. The probabilities are that when figures are adopted we will have two, one for what we call Western silica and one for Eastern silica.

MR. MCDOWELL:—I believe that 2.33 is a fair average for the specific gravity of brick now being made from Medina rock.

MR. GREAVES-WALKER:—Have you not found, Dr. Harvey, that the average brick made of Baraboo quartzite will run 2.33 to 2.34?

DR. HARVEY:—Yes, the figures that Mr. McGee and I arrived at in the paper that has been spoken of showed a difference of 0.016 or, in round number 0.02. Baraboo is higher, I think, by 0.02.

MR. ROSS:—Now that you have spoken of this difference, I would like to have somebody explain why it is.

A MEMBER:—Although I have been far away from this proposition for a few years I recall the original work we did. As far as the structure and the constituents of the Baraboo was concerned, we really saw nothing that was strikingly different from that of the Medina. Our thought all along was that the changes affecting the specific gravity should go closely hand in hand, whatever they were.

MR. GREAVES-WALKER:—You probably know that brick made from Medina quartzite is generally burned at a lower temperature than Baraboo quartzite. Some few plants in Pennsylvania burn silica brick to cone 18, but in the West it is not unusual on coke oven work to burn to cone 20 and still get higher specific gravity, showing there is some physical difference. There is certainly some physical difference in type of the rock. It seems harder to bring about the same amount of inversions under the higher temperature conditions with the same length of burn. Have your investigations shown that, Dr. Harvey?

DR. HARVEY:—I am doing all the talking but McGee did all the work. We found that with the Median quartzite, brick which was burned in the commercial burn and reburned for 48 hours at 1450°C, will practically reach the limit of conversion.

With Baraboo quartzite, we found that with 2 or 3 heatings at the same temperature you do not get to the same limit of possible conversion. There is a difference in the rate of conversion. We have an extreme example of that in the quartzites of which Dr. Endell spoke yesterday, where the conversion is even more complete at a much lower temperature and a shorter time. I am not explaining to Mr. Ross why it exists, but we can not get around the fact that it does exist.

MR. GREAVES-WALKER:—We have in this country those erratic quartzites of which Dr. Endell spoke. Quartzites from Flint, Indiana, will give you exactly the same results as Dr. Endell got with that one particular German flint. It is the same type of rock from which the Indians made their arrow heads. You can get a very high inversion at a comparatively low temperature, showing there is quite a difference in the rate of inversion in different quartzites.

MR. ROSS:—I think the point has been clearly brought out that there is difference in the rate of inversion, as Dr. Endell stated yesterday, in the different quartzites, some fast and some slow. It seemed to be the fineness of the size of crystals. There are certain grades of quartz throughout the country, such as from certain states in the Rocky Mountains, which have not been successfully used in the manufacture of silica brick. They have developed a punky structure which converts very fast. Is there anybody familiar with that? Is there any connection between the rapidity of transformation and structure, or are there certain impurities in those massive quartz deposits that cause the material to transform very rapidly?

MR. GREAVES-WALKER:—Dr. Washburn offered a theory yesterday that was new to me, that of "colloidal quartz" which possibly may help us. When we want to explain why, we will simply tell them, "Why one is colloidal quartz and the other one is not." I am sure, Mr. Ross, I do not know. There has never been any work done on these various quartzites to find out why some of them act as they do, but we have quartz in this country that will give us 80% cristobalite in the regular commercial burn, all the way from cone 15 up to cone 20. There is a difference in their physical appearance but they are all silica—they are all of the same analysis. They appear to make the same kind of a product if they have the right kind of treatment but nobody seems to have found just why we have these differences in the rock or in the product.

BY R. M. HOWE[1]:—One may conclude from Dr. Endell's paper that he is primarily interested in the strength of silica brick at high temperatures and in their tendency to expand (permanently). The writer agrees with him regarding the importance of these properties but not as to the method of measurement.

Silica brick are extremely difficult to cut without fracturing and are sensitive to rapid changes in temperature, especially below 800 °C. Consequently the American practice of heating full sized brick to 1500 °C in $6\frac{1}{2}$ hours appears to possess more merit than this method of heating a small specimen to a higher temperature in 2 hours. The principle of carrying

[1] Received August 9, 1922.

the test to the point of failure is worthy of consideration however, for this is successfully applied in the testing of magnesia and chrome brick under pressure. While the weaker brick are eliminated under pressure of 25 lbs. per sq. in. per $1^1/_2$ hrs. at 1500 °C, no comparison between the stronger is obtained with the standard A. S. T. M. test for silica brick. Both methods might be improved by heating full sized brick at a slow rate to the point of failure, thereby gaining the stronger points of the two practices.

Dr. Endell determines the burn of a silica brick by three different methods—measurement of the permanent expansion at high temperatures, specific gravity and micro-analysis. While all three methods are useful it is quite likely that the specific gravity test is sufficient in most cases. It is simple, accurate, and rapid whereas the micro-analysis is difficult and the expansion test of low precision. This low precision is due to the smallness of the sample (50 mm.,) involved and the tendency to crack under rapid heating (1600 °C in 90 minutes). We have found it to be impossible to secure satisfactory expansion tests on silica brick where they are heated to 1400–1500 °C in 6 hours because of their tendency to fracture under rapid heating. This criticism is removed however, when the test specimens are heated more slowly as at the Semet-Solway Co. laboratory.

During the discussion, values of 2.33 and 2.34 were mentioned as representative for the specific gravity of well burned silica brick. While picked samples may have these or even lower values the run of kiln will be denser.

DISCUSSION ON "THE INFLUENCE OF GRIND AND BURN ON THE CHARACTERISTICS OF SILICA BRICK"[1]

F. A. HARVEY:—There is one point, that of methods for determining the effect of fineness of grind on the modulus of rupture, which is very important. In the open hearth, the problem of spalling seems to be one of importance. Coarsely ground brick work better in open hearth furnace than do finely ground brick.

R. M. HOWE:—When this particular study was started there was considerable talk about basing a specification for silica brick upon the modulus of rupture. Consequently we were very anxious to learn to what extent this property was controlled by the present method of grinding and burning. It developed that the time of grinding was of very little influence although the temperature of burning was extremely important. The fact that spalling is a very important problem was not overlooked but was simply omitted in this particular study.

[1] This is a discussion of the paper by R. M. Howe and W. R. Kerr, *Jour. Amer. Ceram. Soc.*, **5**, 164 (1922). Discussion before the Refractories Division, 1922 Convention, St. Louis.

MR. J. S. MCDOWELL:—In connection with silica brick in open hearths it seems there are other characteristics than spalling which affect their life. For example, in the basic open hearth we find that the life of the roof-brick will vary from 200 to 300 heats—probably an average of 250. In acid open hearths, brick of the same brand will last from 1000 to 1500 heats. This strongly suggests that the action of some furnace products has an effect upon subsequent spalling after the brick has been in use for some time.

MR. GREAVES-WALKER:—In line with what Mr. McDowell just stated in regard to the characteristics of silica refractories in roof work, I wish to relate conversation had with the president of a steel foundry company a few days ago. He is operating six ton electric furnaces. They were running basic up to a year ago and were getting the average number of heats from their roofs; then they changed to acid. He told me that under acid conditions he was having absolutely no trouble at all. I think this shows undoubtedly that the volatilized lime from the slag in the basic practice has a great deal to do with the destruction of silica roofs.

MR. MCDOWELL:—I really doubt that the study of the spalling characteristics of silica bricks will give a great deal of indication of the service of the roof for the reason that after a brick has been in service a short while it is not the same brick. A number of studies have been made which show the changes which take place in the composition of roof brick while in service. I believe Dr. Endell has collected some data on the subject and a very good paper has been published by Rengade in France. It appears that considerable lime and ferric and ferrous oxide are absorbed, so that silica brick, exposed to furnace gases, instead of having a silica content of approximately 96 per cent, after having been in use for a while, may have a silica content under 90 per cent on the end exposed to the heat. Naturally the spalling characteristics of such a brick would be altogether different from those of an unused brick.

MR. W. A. HULL:—This may not be new, but in connection with what Mr. Howe was saying about hard burned brick not standing up against spalling as well as light burned, I might add that when Professor Fearnside of Sheffield University, England, was at the Bureau of Standards recently, I asked him what they did in England in the way of making repairs upon open hearth furnaces. He stated that they used very light-burned brick, they having given the best results and the least spalling.

DR. HARVEY:—I want to add one thing to what Mr. Howe said about this test on spalling. I do not think the results could be held as establishing the fact that you have the least spalling in service with an under-burned brick. We were trying to determine a method of testing resistance to spalling. The Carnegie Steel Company have a method which they recommend for testing spalling of silica brick in a furnace temperature of

540°C. They heat the brick for an hour and then plunge into cold water. Now the most rapid expansion in silica brick occurs between the temperature of cold water and 540°C. In this spalling test the brick are heated back and forth through this expansion range, which is something that does not happen in actual practice.

In actual practice, I do not believe we have anything which shows that under-burned silica brick, or light burned silica brick, stand better than the hard-burned brick. This test shows, and the results show, as far as the test is concerned, that under-burned brick will stand the test better than hard-burned brick, but I do not believe it necessarily follows that that would be true in actual practice.

MR. HOWE:—These results justify the practice of using different grinds for the nine inch and shape mud, for the strengh of the finished products will be similar. The fact that two widely different grinds are used interchangeably also tends to substantiate the results of this investigation. These statements assume, however, that the grind is the only variable involved.

MR. MCDOWELL:—In connection with Mr. Howe's remarks, I believe there is a certain amount of evidence that in certain operations an under-burned brick shows less spalling than a well-burned one. Le Chatelier seems to have observed something of that kind for in one of his papers he says, in effect, that a light-burned silica brick is mediocre, a hard-burned brick is good, but a medium burned silica brick is detestable.

MR. GREAVES-WALKER:—Is it not true that to make a better silica brick we have been attempting to get 100 per cent tridymite-cristobalite content, which would mean a hard, dense brick, possibly the densest silica brick we can make, in order to make it stand up longer under thermal shocks?

MR. HOWE:—There has been a decided tendency to burn harder and the results obtained in practice seem to justify the extra expense when the brick are exposed in service to the highest temperatures. At lower temperatures, however, hard burning is of no advantage and may sometimes be a disadvantage. These conditions are proven by the fact that hard burned silica brick give very good service in open hearth roofs and coke-ovens when compared with those which are light burned. On the other hand light burned sand rock brick give extremely good service in furnace roofs where lower temperatures are involved. Thus the problem of spalling is by no means simple and the success or failure of a given type of silica brick will depend entirely upon conditions.

MR. MCDOWELL:—The present tendency to burn silica brick at high temperature has come about from the desire to eliminate, so far as possible, the residual expansion and was not based on the effect upon spalling.

MR. GREAVES-WALKER:—I think that was also taken into consideration. If you get increased inversion, you would reduce spalling.

MR. MCDOWELL:—I do not believe that has been done commercially.

MR. GREAVES-WALKER:—Dr. Endell, what is the German experience with silica brick, so far as spalling is concerned, between the light burned, medium burned and hard burned brick?

DR. ENDELL:—In our own steel plants we have only hard burned brick, burned in the same manner as burned here; and, as far as I know, they are using only hard burned silica brick for open hearth furnaces.

MR. GREAVES-WALKER:—Do you notice any difference between the hard brick and the soft brick, so far as spalling is concerned, and the resistance to thermal shocks?

DR. ENDELL:—I have not made a special investigation of spalling but I believe the spalling of silica brick depends on the amount of quartz, and this depends upon the burning temperature.

MR. MCDOWELL:—The light burned brick, such as we have been speaking of, would contain considerable quartz and not a great deal of cristobalite. It is probable that, so far as spalling is concerned, cristobalite is more harmful than quartz. I believe the thermal expansion curves of the two minerals would bring one to this conclusion.

FIRE CLAYS OF IOWA

NOTE BY PAUL E. COX

Milton F. Beecher[1] has made the only investigation on Iowa fire clays. Mr. Beecher did not find any fire clays in Iowa worth exploiting. Iowa has coal measure clays, many of them having been used in stoneware manufacture. The clay at Sargeant's Bluff in the western part of the state is the most refractory but it is not a refractory clay.

There is no reason to believe that Iowa will produce refractories.

DISCUSSION[1] ON "DATA ON OPERATION OF A CONTINUOUS TUNNEL KILN AT THE PLANT OF THE A. C. SPARK PLUG COMPANY, FLINT, MICH."[2]

MR. STAUDT:—I have had considerable experience with kilns, including a tunnel kiln which was not satisfactory and had to be torn down.

My experience with the tunnel kiln cost me good money, but I do not regret it as it proved to me that it is necessary to have a small tunnel kiln for small ware that requires very accurate firing both as to color and size. Such a kiln may not be so efficient so far as fuel economy goes, but it does

[1] *Trans. Amer. Ceram. Soc.*, Vol. XVII, 102 (1915).

[1] Whitewares Division, St. Louis Meeting, Feb. 28, 1922.

[2] McDowell and Helser, *Jour. Amer. Ceram. Soc.*, **5**, 267 (1922).

the work and saves in the quantity rejected. It is my opinion that you should have a big kiln for big ware and a small kiln for small ware.

MR. GOODWIN:—How do they determine the heat, when passing through the different zones, with cones?

MR. MCDOWELL:—The cones on any of the cars may be seen at any time from the open entrance to the tunnel. The fireman, knowing at what position in the hot zone he can expect the maximum heat, can, therefore, use the cones as a close check on the pyrometer.

MR. SCHRAMM:—Was the temperature gradient along the length of the kiln determined with a long thermocouple?

MR. MCDOWELL:—Yes. The temperature was read from a thermocouple extending up thru the bottom of a car to the level of the ware. This couple was attached to the pyrometer all during its travel thru the kiln, and readings were taken every foot of length.

MR. KLEIN:—Have you any way of measuring the temperature of the arch in the hot zone?

MR. MCDOWELL:—None except our pyrometer readings. The thermocouples extend through the arch and into the kiln six inches. These thermocouples show a temperature of 1440°C.

Mr. KLEIN:—Has the arch ever been replaced?

MR. MCDOWELL:—The arch has never been touched.

MR. SCHRAMM:—The good results reported by the authors, and especially their success in firing without saggers, are to be attributed chiefly to close control over firing conditions. The earliest work on surface combustion was done in this country by Professor C. E. Lucke; later, Bone, in England, independently developed furnaces working on this principle. For a time there was considerable speculation as to the nature of the process. In an early type of furnace, the mixture of gas and air under pressure was fed into a bed of granular refractory material within which combustion took place. Unusual results were obtained in the way of attaining high temperatures with a minimum consumption of gas. Among the factors contributing to this were:

1. Thorough mixing of the gases in passing through the bed.
2. Acceleration of combustion, due to contact between gas and solid.
3. The storing up of heat in the refractory bed and its emission in radiant form.
4. The "baffling" action of the refractory which permitted the gas-air mixture to be fed under considerable pressure without blowing out.

The net effect of these conditions was to permit complete combustion without excess of air, giving high efficiency, and to increase the amount of gas that could be burned in a given combustion space, promoting high temperatures. In the commercial application of these principles it has been found necessary in many cases to abandon the use of the refractory

bed, and to that extent to return to ordinary methods of firing, in which surface action is by no means absent. However, it would seem that so long as it is possible to achieve complete combustion of a theoretical mixture of gas and air, the chief advantage of the new system has been retained.

MR. A. W. BUCKINGHAM:—Two features of this kiln illustrate a tendency in present day kiln construction which make for better control:

First, the cross section of the kiln is as small as possible, consistent with the production required.

Second, the large number of burners in the firing zone undoubtedly permits considerable flexibility in "soaking" time.

Several points have occurred in reading over this paper which we believe the authors should have brought out:

What is the approximate cost of the different kilns?

MR. P. D. HELSER:—Due to the fact that both kilns were built during a period of high prices, the replacement cost at the present time can only be approximated.

The approximate replacement cost of the smaller kiln would be $10,000, while the corresponding figure for the larger kiln would be $20,000.

MR. A. W. BUCKINGHAM:—It is natural to suppose that heating up and cooling down a tunnel kiln would cause more or less wear and tear on the structure. The authors state that after two years of operation there has been very little damage to the kiln on account of this intermittent operation. To what particular features of the construction or operation do they attribute this?

MR. P. D. HELSER:—Small size, simple construction, and the nature of the refractory materials used in construction, are the factors which account in large measure for the slight damage.

MR. A. W. BUCKINGHAM:—The width of the kiln is given in the paper but not the height of the crown of the arch above the deck of the kiln car. It would be interesting to know how much space there is above the material being fired.

MR. P. D. HELSER:—This must necessarily depend upon the nature of the fuel and the difference in volume of the resulting combustion products.

MR. A. W. BUCKINGHAM:—Drop arches in the preheating zone should serve as effective baffles provided they extend down fairly close to the deck of the kiln car. How much below the crown of the main arch do these baffles extend?

MR. P. D. HELSER:—This depends upon the nature of the ware fired and its ability to withstand rapid preheating.

MR. A. W. BUCKINGHAM:—Manufacturers of this grade of ware would be interested in learning what the unit fuel consumption is, that is, cubic feet of gas per ton of ware, etc.

MR. P. D. HELSER:—The only ware burned in these kilns in quantities has been spark plug porcelain insulators. On this account figures on no other types of ware are available, and a comparison on a tonnage basis would obviously be meaningless.

MR. A. W. BUCKINGHAM:—The method of taking temperatures for the full length of the kiln at twelve minute periods is a novel one and certainly should be very accurate. Do the authors suggest this as being a practical method of taking temperatures at frequent intervals throughout the day?

MR. P. D. HELSER:—Yes, it serves as a very satisfactory check.

MR. A. W. BUCKINGHAM:—The second installation is described as being about twice the width of the smaller one. What is the total burning time in the longer kiln as compared to the twelve hours for the first installation?

MR. P. D. HELSER:—The total burning time is the same in both kilns.

PROF. C. B. HARROP:—For the firing of a shallow layer of small size ware, made from a body mix that will stand rapid heating and cooling, the above described kiln is undoubtedly a real success. However, for capacities such as are being secured from some of the other tunnel kilns firing sanitary ware, general ware and electric porcelain, this type of kiln would be entirely out of the question.

The Surface Combustion firing equipment is probably responsible to a large extent for the success of the kiln. Any other system of fuel application would undoubtedly result in so much greater volume of combustion gases that the temperature at the charging end of the kiln would be excessive and serious damage would occur to the entering ware. The Surface Combustion principle of firing gives an intense temperature in a restricted space which is absolutely necessary in a kiln of this length.

If the authors had given more real operating data, their paper would be of far greater practical value. It would be very interesting to know:

(a) Tonnage or number of pieces fired per 24 hours.
(b) Cubic feet of gas required per 24 hours.
(c) Total power required to operate the kiln.
(d) Labor required to operate the kiln.
(e) Cost of repairs—average over a long period.
(f) Approximate total cost of kiln.

MR. P. D. HELSER:—This kiln was designed for the purpose of burning one special type of ware to a comparatively high temperature. The kiln has given entire satisfaction for the purpose intended, and no extensive investigations on the firing of different types of ware have been made.

The kiln was designed and built to meet our special need, with no idea of further exploitation, therefore nothing was to be gained by giving it undue publicity.

While the Surface Combustion firing equipment is considered a successful accessory to the operation of the kiln, any efficient premixing device

delivering a correctly proportioned mixture of air and high-flame-temperature fuel would answer the purpose.

In fact, on account of the varying quality of the gas this Surface Combustion equipment requires constant adjustment to maintain correct combustion conditions and to give a desirable kiln atmosphere which is so essential to insure satisfactory burning conditions in any firing process.

Measurements as made on the larger kiln show a power consumption of fifteen H. P., which includes one H. P. for the pushing mechanism, four H. P. for the cooling fan, and ten H. P. for the operation of the blower furnishing the air for combustion.

The labor required to operate the larger kiln is one man full time, and an additional man one-half time.

The only data available on maintenance cost is that on the smaller kiln which was in operation for over two years. This cost approximated $200.00.

By C. C. Treischel:—The kiln described is a remarkable innovation in kiln building but I believe that its field is very limited, due to the fact that porcelains fired in it must be small and capable of absorbing heat very rapidly. Furthermore, I believe that a multiplicity of designs and sizes, such as is met with in practically every line of whitewares manufacture, excepting spark plug porcelains, would lead to difficulty because of continual readjustment of the control mechanism to meet operating conditions.

There is also some doubt in my mind regarding the relative degree of maturity of the top of the ware and the bottom, that is, in this case the tip of the spark plug porcelain in the one case and the top or large end in the other. It seems to me that the tip being more exposed to the reflected heat in the kiln would be matured more than the larger end which is against the bottom of the tray. This might not be a disadvantage in spark plug porcelains but would be in the case of most designs used in the whitewares industry.

However, the builders of this kiln must be congratulated because they have evidently solved their individual firing problem, which is more than most of us can say for ourselves.

DISCUSSION "THE FIELD OF PORCELAIN GLAZES MATURING BETWEEN CONES 17¾ AND 20"[1]

By H. H. Sortwell:—Mr. Twells' work was admirably chosen in that it filled a vacancy so that now from the work of Stull, Stull and Howat, the writer, and Mr. Twells closely agreeing data are available on this type

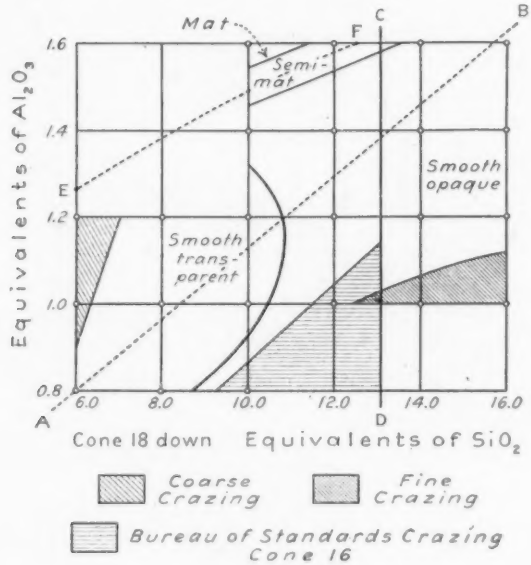
[1] *Jour. Amer. Ceram. Soc.*, **5**, 430 (1922).

of glaze covering the wide range in temperature of from cone 9 to cone 20.

Considering the difference in materials, methods, and medium of firing the agreement of the results from cone $17^3/_4$ to cone 20 with those obtained at the Bureau of Standards is surprisingly close.

Below is reproduced Mr. Twells' Fig. 5 representing his results at cone 18, with the results of the writer in that portion of the field at cone 16 superimposed thereon for comparison.

The dotted line AB which practically bisects Mr. Twells' field shows the location of the glazes designated by the formula Al_2O_3 = 0.3 plus $^1/_{12}$



Twells' Fig. 5

AB – Al_2O_3 = 0.3 plus $\frac{1}{12}$ SiO_2.
CD – Upper limit in SiO content of Bureau of Standards glazes.
EF – Limit of area of bright glazes at cone 16.

SiO_2 which was derived from the results obtained at the Bureau of Standards and was given as the axis along which the best glazes lie. The line CD indicates the upper limit in silica content of the field of glazes studied at the Bureau, the dotted line EF shows the limit of the area of bright glazes at cone 16, and the horizontal hatching denotes the crazing which occurred at the same temperature. The agreement is evident.

The recession in the crazing area is about what would be expected had the trials been the same in both cases. The coarse mesh crazing noted by Mr. Twells is evidently the type of crazing referred to by the writer as crazing caused by overfiring. It was to be expected that the failure of some

of the high flint glazes to lie down to smooth surfaces reported by the writer, would not occur in the field studied by Mr. Twells. The glazes in which this appeared were very much lower in alumina and were the only glazes in the Bureau of Standards compositions which contained more than 55 per cent flint excepting one of higher alumina content.

BUREAU OF STANDARDS

DISCUSSION ON "COMPARATIVE TESTS OF AMERICAN AND FOREIGN TABLEWARE"[1]

BY H. F. STALEY:—Mr. Sortwell has done a very nice piece of work in devising and applying comparative tests to American and foreign tableware. It is very pleasing to learn that American wares show up so well in the various tests in comparison with the foreign makes. This is only one more proof that the manufacturers of ceramic products in this country need not fear public tests of their wares in comparison with those of foreign makes. In every case where a certain quality of ware has been demanded, the American tableware manufacturers have been able to produce it. If comparative tests of any other ceramic product should show that the American material is inferior to the foreign material, we can rest assured that the American ceramic manufacturers have sufficient ability and ingenuity to speedily correct the defect. In other words, the ceramic industries in this country will have nothing to fear from publicity and have much to gain.

AN ACCOUNT OF AN INVESTIGATION OF SOME GEORGIA CLAYS AND BAUXITES[1]

BY R. B. GILMORE AND A. H. FESSLER[2]

Introduction

Through the central part of Georgia, and traversed by the Central of Georgia Railway Company's lines, lies a belt known as the coastal plain containing large deposits of clays and bauxites. Besides this a small area occurs in the northwestern part of the State. These deposits vary from typical kaolins on the one hand to high grade bauxites on the other. The belt is two hundred and twenty-five miles long and varies from twenty to fifty miles in width. They are for the most part surface deposits with very little or no overburden, attaining a thickness in some places of forty feet. Deposits of from four feet to twenty feet are common. The fields have been worked to some extent but never have been developed for the ceramic

[1] Sortwell, *Jour. Amer. Ceram. Soc.*, **5**, 276 (1922).

[1] Published with the permission of the Director of the U. S. Bureau of Mines.

[2] Received July 18, 1922.

trade to the degree to which they are worthy. The railway company realizing this fact, and the great potential wealth of the deposits, is carrying on an extensive investigation of these clays and bauxites through a coöperative agreement with the U. S. Bureau of Mines. The Bureau in turn is coöperating with ceramic industries for making large scale practical tests to confirm the laboratory findings.

The work has been in progress over a year and will be continued to completion. The tests are made on a semi-commercial scale in order to obtain practical data on the value of these materials for commercial purposes. Two ton samples from each of twenty-four of the most typical deposits were sent to the Ceramic Experiment Station at Columbus, Ohio, where tests are being made. The final phase of the investigation will be to put these clays through the commercial practices for which they appear to be best suited as indicated by preliminary laboratory tests.

The clays, roughly classified into two types, are included in the investigation, namely, those suitable for pottery and allied products and those suitable for refractories. The main investigation on the white burning clays consists of developing improved refining methods with the objects in view of eliminating undesirable impurities and producing a more uniform product. In the refractory work, both small and large scale tests are made to determine the behavior of the raw materials under manufacturing practice and the serviceability tests are to be made under actual furnace conditions.

Preliminary Tests

Preliminary tests were first made on the samples to determine the physical properties of these materials in order to indicate the purposes for which they were best suited. The tests included shrinkage, both drying and burning, porosity, burned color and fusion temperature on raw material together with viscosity determinations on the slips. The viscosity tests were made to determine the proper amount of caustic soda to be used in the washing so that the most efficient separation of impurities might be obtained.

Refining Study

Besides a blunger, agitator, filter press, and other auxiliary machinery commonly used for preparing the slip and collecting the washed clay, the clay washing apparatus consists of two elutriating cans and a "whirlpool" clay separator built according to design of Mr. R. T. Stull, Supervising Ceramist of the U. S. Bureau of Mines. This separator is in effect an elutriator in which the slip enters tangentially and near the top instead of through a pipe down the center to near the bottom. A whirlpool action is caused which throws the coarser particles toward the center and down, where they are collected in a container attached to the bottom of the can.

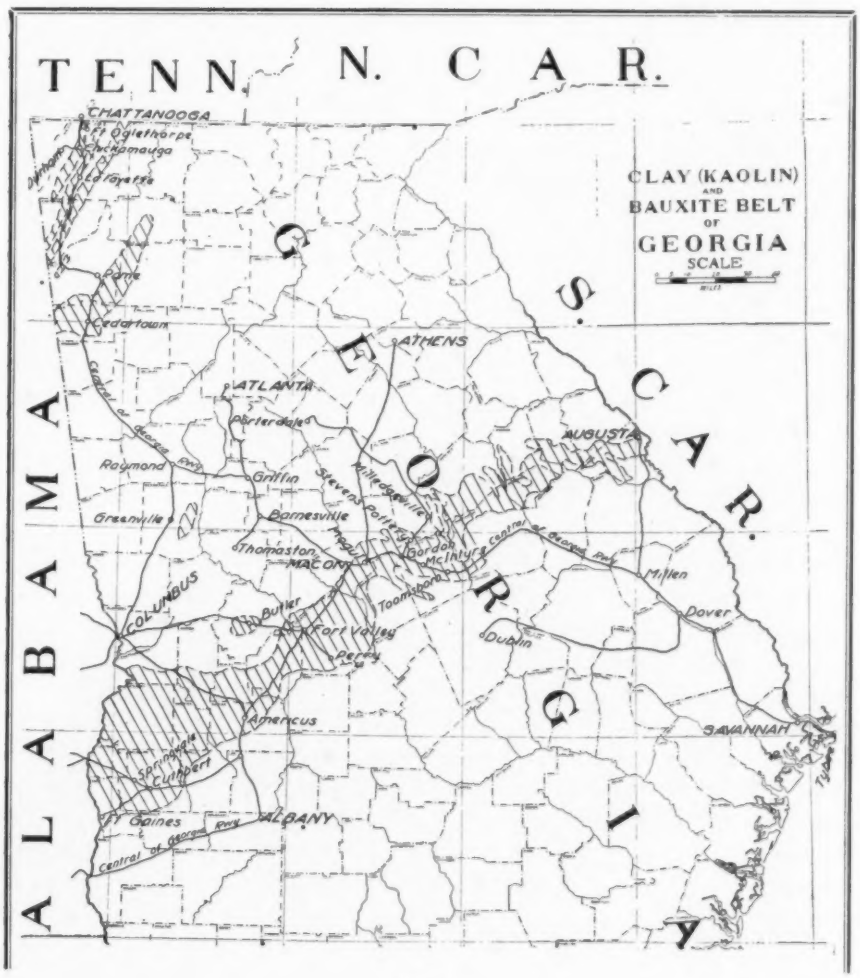

TENN.
N. C A R.
S. C A R.
A L A B A M A
G E O R G I A
CHATTANOOGA
Ft Oglethorpe
Lafayette
Cedartown
Rome
ATHENS
ATLANTA
Peachtree
Raymond
Griffin
Milledgeville
Greenville
Barnesville
Thomaston
MACON
COLUMBUS
Butler
Fort Valley
Perry
Americus
Dublin
Dover
Millen
AUGUSTA
SAVANNAH
Ft Gaines
ALBANY
Central of Georgia Ry
CLAY (KAOLIN)
AND
BAUXITE BELT
OF
GEORGIA
SCALE

FIG. 1.

A paper in the *Journal*, giving in detail a description and principles of operation of this separator, will be published later. The elutriating cans are large, each being four feet high, one is three feet and the other five feet in diameter. The capacities are one hundred and sixty-five and four hundred and fifty gallons, respectively. The arrangement is such that the slip after passing through the screens is then passed through the separator, then through the elutriating cans and finally the overflow from the larger can is caught in a seven hundred and fifty gallon settling tank.

A thousand pounds of clay are blunged at which time caustic soda is added to accomplish deflocculation and when blunging is completed the slip is passed through a nest of standard screens, Nos. 8, 20, 65, 100 and 150. It is then pumped into an agitator overhead and run through the washing system, a constant head being maintained to assure a constant rate of flow.

There are five separations derived in this operation after the clay slip has passed the 150 screen. The majority of the impurities are contained in the first one, or the residue in the grit collector of the "whirlpool" separator, while the separate, or material deposited in the settling tank, is in most cases practically free from impurities, consisting almost entirely of kaolinite. The apparatus has produced very favorable results and unless the impurities are in an extremely finely divided state they may be removed, producing a clay which burns to almost a snow white color and free from small objectionable specks. A slight trace of very fine quartz grains in some cases was the only foreign material found in the washed product, when examined under the microscope. The "whirlpool" separator, besides removing the fine grit, also removes the thin mica flakes which are not eliminated under present clay-washing practice. The recovery of valuable clay is also higher.

Such pleasing results have been obtained in some of the samples washed that several hundred pounds of the refined material have been sent to manufacturers making various kinds of white ware in order to test the pottery-making properties of these refined clays in a practical way. The clay will be put through actual commercial practice in the manufacture of pottery, wall and floor tile and electrical porcelain. In this way the working, drying and burning properties may be ascertained in the plastic, dry press and semi-dry press process. This phase of the work is to be of such an extensive nature that complete data on the clays tested may be available for users of white clays.

After the washing investigation has been completed at the Ceramic Station, it is planned to remove the washer to some point in Georgia and continue the work on a practical basis. Work will also be done, either at the Station or in Georgia after the washer has been set up there, on the dewatering of clay slips by methods other than filter pressing. Several

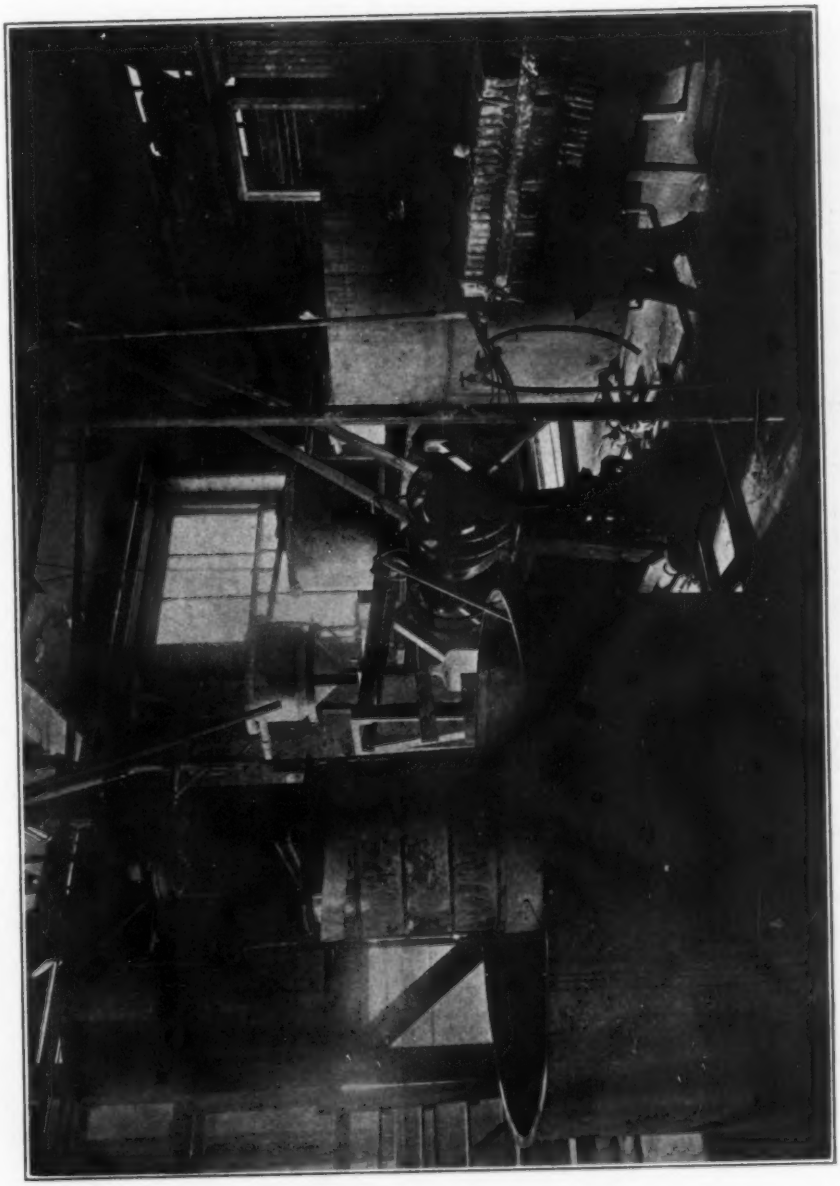


FIG. 2.

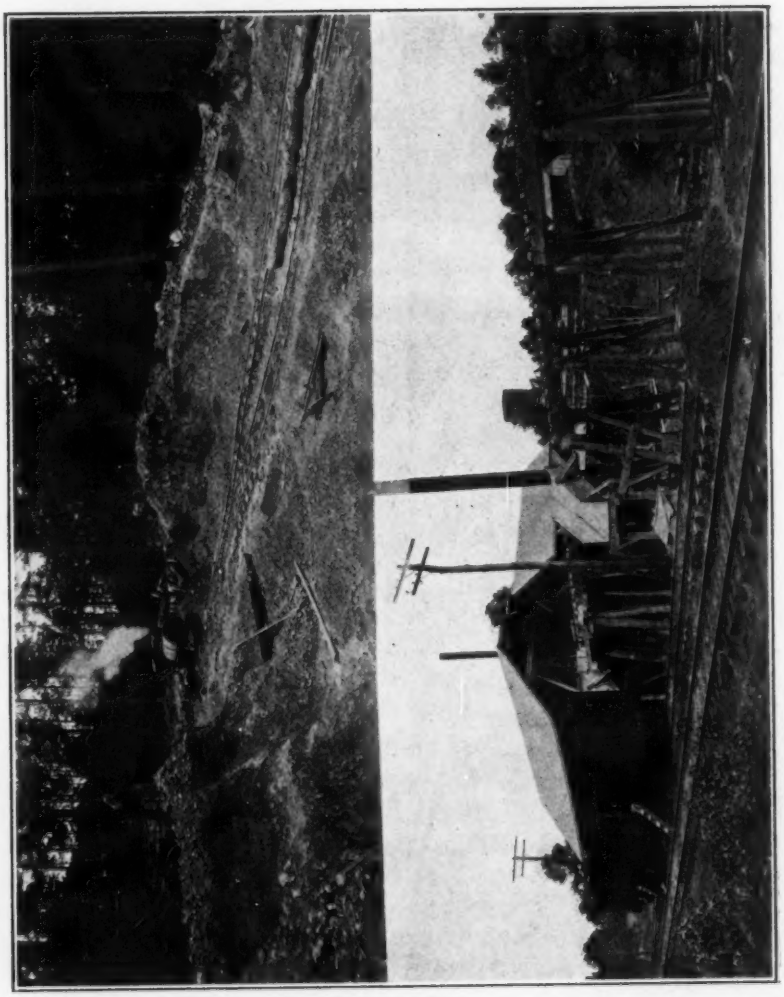


FIG. 3—General Bauxite Co., Nadine, Ga.

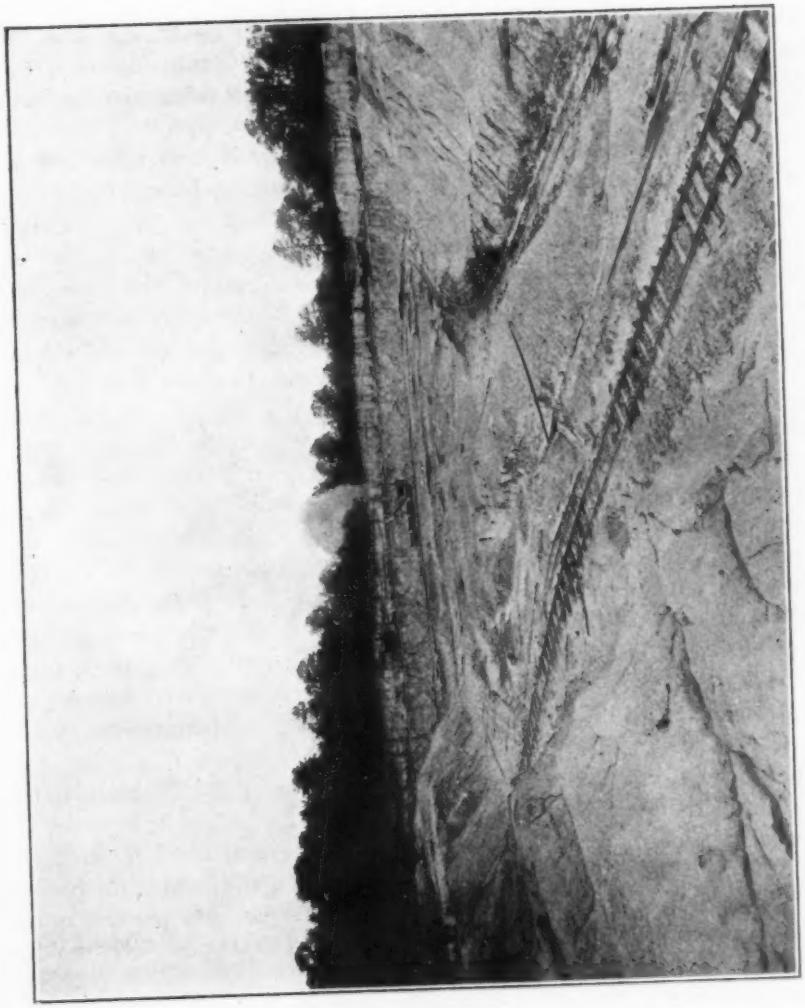


FIG. 4.—Edgar Bros. Co., McIntire, Ga.

work was suggested on account of the fact that filter pressing is comparatively expensive and in exceptional cases appears to render the clay unsuitable for certain purposes.

Refractory Study

Although the refractory study has only been started, sufficient work has been done to determine which clays are particularly valuable for refractory purposes. The laboratory work, thus far, in this connection has been confined largely to fusion, spalling and load tests.

The samples chosen for this study were divided into three classes, those properly classed as (1) clays or kaolins, (2) bauxitic clays, and (3) bauxites. Besides the bauxites, nine clays and five bauxitic clays seemed worthy of investigation for refractory purposes. To supply the grog for the refractories made from clays (Class 1), samples of these clays were calcined to cone 14 and ground to pass a No. 10 mesh screen. Sixty per cent of each grog thus prepared was mixed with forty per cent of the same raw clay to serve as the bond. Bricks of the standard size were made of these mixtures by the dry press process and burned to cone 14. The porosities were determined on the whole brick by the gas expansion porosimeter and the bricks subjected to the standard spalling test. Ten quenchings were made and the loss in weight taken as an indication of the resistance to sudden temperature changes.

Load tests at furnace temperature were also made on some of the fire-brick which indicated remarkable resistance to spalling. Some phenomenal results were obtained in the load tests and in two cases especially the results of the spalling tests were far above the average fire brick, the spalling loss being less than 0.60 per cent. In the fusion tests not one of the samples gave a fusion temperature below cone 34, approximately 1740° C or 3164° F.

The samples of bauxites and bauxitic clays were made into bricks in the same manner except that the grog samples were calcined to cone 17. Because the raw materials were low in plasticity and bonding strength, one of the clays of good plasticity which had given high scores in the fusion, load and spalling tests was selected as the bond. Seventy per cent of the calcined material was mixed with thirty per cent of the bonding clay molded dry press and burned to cone 16.

The clays which showed exceptionally good results in these tests will be tested in a practical way on a much larger scale. A carload of one of the most promising clays has been shipped to a well known fire-brick plant where it is to be made up into standard refractories. Arrangements have already been made to test these refractories for locomotive arches, malleable iron furnace bungs and electric furnace linings. A sample of bauxite

FIG. 5—Savannah Kaolin Co., Gordon, Ga.

has been sent to the Bureau of Mines Experiment Station at Seattle, Wash., where it is to be sintered, made into refractories and tested as a lining in an electrically heated high temperature metallurgical furnace. Although the work at present time has not been completed, enough has been done to indicate the ceramic possibilities of this extensive belt of clays and bauxites.

COLUMBUS, OHIO.

ACTIVITIES OF THE SOCIETY

Increase in Membership Support

Twenty personals and five corporations is the gross score for August. There has been the normal loss (1 associate) this month. The net increase in members for the first seven months of this calendar year is:

	Personals	Corporations	Total
August 10, 1922	1509	188	1697
January 1, 1922	1350	139	1489
Net Increase	159	49	208

The membership status and gains for the past five years are here shown:

	Record		Increase	
	Personal	Corporation	Personal	Corporation
February 1917	537	None		
February 1918	717	33	180	33
February 1919	911	73	194	40
February 1920	1133	94	222	21
February 1921	1243	105	110	11
January 1922	1350	139	107	34
At Present Time	1509	188	159	49
		Total	982	188

It is remarkable that in the years preceding the present, practically all of the additional membership support was secured during the later months of the year. This year there has been a steady net increase, in fact the membership has steadily increased since the Society has had a full time secretary, not directly because of his activities but because of the larger service which the Divisions and standing committees have rendered.

The gross increases in membership by periods since June last year are:

	Personals	Corporations	Total
1921 June to September	41	11	52
Sept. to December	18	2	20
Dec. to February, 1922	136	21	157
1922 Feb. to May	81	10	91
During May	13	13	26
June	13	5	18
July	25	11	36
August	20	5	25
Gross Totals	347	78	425
Loss	81	5	86
Net increase	266	73	339

The average monthly gross addition from June to June was a little better than 25 personals and 5 corporations. During the past summer months there was a falling off

in the "batting average" of the team as a whole notwithstanding the large scores made by A. F. Hottinger, B. E. Salisbury, O. O. Bowman, 2nd and C. E. Bales.

The team is now getting into its winning stride; things are getting back to normalcy. If history will repeat, and it always does with those who are in earnest, our present team of 1697 members will from now on run up a much larger average each month. Our team has always played better and more consistent in the fall and winter months; indeed with increasing monthly averages.

A statistician would figure from the "laws of averages" in our case, that a reasonable expectancy would be a net increase of 200 personal and 100 corporation members during the next three months. This would be based largely on the more general coöperation now being shown by the individual members, and by the more active and efficient Division organizations.

A. F. Hottinger

B. E. Salisbury

The following shows the hitters, and the scores made by each, during the months of July–August.

		Personal	Corporation
R. R. Danielson; P. D. Merica; W. S. Williams; W. M. Clark; W. A. Hull; H. H. Sortwell; J. W. Cruikshank; D. H. Fuller; R. F. Segsworth; August Staudt:	1 each	10	..
C. E. Bales; G. R. Truman	2 each	4	..
Mrs. Arthur F. Weaver		3	..
O. O. Bowman, 2nd		1	2
A. S. Zopfi		..	2
Secretary's Office		2	1
		20	5

The Society is now doing more real constructive work than at any time in the past; the Industrial Divisions and the committees are functioning, not 100%, but consider-

ably more than at any time heretofore. We can continue with the larger and more interesting *Journal* if the members secure the required financial support.

The business of the Society is being handled as economically as is consistent with making progress. The Board of Trustees has proceeded on the policy of making an article for which there is a demand, then showing it, and in all legitimate ways promoting it.

The service rendered by the Society is measured by the *Journal* but it is not altogether the *Journal*. The original papers, the discussions and the abstracts published in the *Journal* are the records of results achieved. The prime service of the Society, making the *Journal* possible is the research promotion and education, decentralized through the several Industrial Divisions, but on a coördinating program.

The Society at the present time is solvent with $12,402 cash (or Liberty Bonds) and $4,098 account receivable. These figures do not include inventories of Transactions, Journals and other publications nor of office equipment. It is not that the Society is financially embarrassed at the present time that new members are required but it is that the expenses are exceeding the income and hence, if the Society is to continue the service it is now rendering, more members will have to be secured.

Even if the income did equal the expenses there would be the same need for vigorous solicitation of additional support, for as the Society continues to serve, the demands and the opportunities for service will increase.

There is no human enterprise, no matter how unselfish and beneficial it is, that does not have to be promoted vigorously if it is to succeed. No Chamber of Commerce, no business man's club, no church or school, and certainly no technical Society can be maintained without continued selling of it to prospective supporters. Our task, therefore, is not for this Fall alone, but for as long as the Society continues. Will each member realize the importance of succeeding with this task that the Society may continue to meet the ever-increasing demand for the peculiar research promotional and educational service for which it is organized?

One hundred and eighty-eight ceramic corporations are now subscribing an annual fee of $25 to the support of the American Ceramic Society that the personal membership may be kept within the financial possibilities of the young men in the plants for whom the educational enterprises of the Society are especially directed. This Society is unique in that the personal subscription has been kept at the low figure of seven dollars and a half. Over 1500 persons are now having the privileges of membership at this low annual fee because of the larger subscriptions paid by corporations by whom the benefits are more largely realized.

Application to industrial problems of results of researches in the fundamental sciences, and of the engineering and technical investigations; surveys of material resources, and processes; standardizing of tests; writing of specifications for materials and products; finding of the most effective process controls; these are the tasks of the ceramic research laboratories. It is such activities as these that the American Ceramic Society promotes and coördinates. This is the modern method of pyramiding scientific facts and theories into industrial processes and products, and at no time more than at present were organized coördinating and promoting services so sorely needed by the ceramic industries. There is an increasing industrial requirement for research work; the federal, state and collegiate organizations are responding; the trade associations are financing; the American Ceramic Society must furnish the clearing house facilities that the work of each of these agencies may be correlated to the largest possible economic advantage. This is why the Divisions and Committees are more active and why the *Journal* has been so largely increased; and, in consequence, these are the reasons for the goal of 200 personal and 100 corporation additional members.

New Members Received from July 13 to August 10

ASSOCIATE

Backus, (Mrs.) Lulu Scott, 451 So. Goodman St., Rochester, N. Y. Head Dept. Crafts, Mechanics Institute.

Branham, Ivan Bundy, 323 So. Chester Ave., Pasadena, Cal. Bachelder-Wilson Co., Los Angeles, Cal.

Harrington, Rufus F., 383 Dorchester Ave., So. Boston, Mass. Hunt-Spiller Manufacturing Corporation.

Hartshorn, Theodore D., Kensington, Md. Ceramic Division, U. S. Bureau of Standards.

Hebden, James B., 1415 Brook St., Louisville, Ky. Louisville Fire Brick Works.

Beggs, F. M., Tiffin, Ohio. United States Glass Works.

Keese, A. W., 16220 Saranac Road, Cleveland, Ohio. The Collinwood Shale Brick & Supply Co.

Kidder, C. Paul, Klondyke, Ohio. Patterson Foundry & Machinery Co.

Lathrop, John Sherman, 603 So. Louisa St., Glendale, Cal. Tropico Potteries.

Matson, J. Burnett, 705 S. Walnut St., West Chester, Pa. Mechanics Institute, Rochester, N. Y.

Merian, Frederic, 3415 Iowa Street, Pittsburgh, Pa. J. W. Cruikshank Eng. Co.

Mudge, William A., International Nickel Co., Huntington, W. Va.

Murray, John C., 66 Barrie St., Kingston, Ont.

Niece, Norman L., Box 348, Arnold, Pa. American Window Glass Company.

Pendergast, W. L., 1775 California St., Washington, D. C. U. S. Bureau of Standards.

Shegog, Thomas A., 167 West 130th St., New York City.

Spencer, Charles D., Nela Park, Cleveland, Ohio. National Lamp Works of G. E. Co.

Thayer, Florence E., 8 May St., Worcester, Mass. Supervisor of Drawing, Worcester, Mass.

Watkins, Jack H., Charlotte C. H., Virginia.

Woods, B. J., Dubuque, Iowa. U. S. Bureau of Standards.

CORPORATION

Baker Bros. Glass Co., Okmulgee, Okla. (W. G. Baker, Pres.)

Chicago Retort & Fire Brick Co., 208 So. LaSalle St., Chicago, Ill. (John H. Cavender, V. P.)

Golding-Keene Co., Keene, N. H. (Charles E. Golding.)

Thomas Maddock's Sons Co., Trenton, N. J. (C. S. Maddock, Jr.)

Sunflower Glass Co., Sapulpa, Okla. (Frank Bostock, Pres.)

Who's Where in the American Ceramic Society

James M. Bonner, formerly of the Zwermann Co., Robinson, may now be found at Abingdon, Ill.

Arthur L. Donnenwirth, who graduated from the Ceramic Dept., O. S. U., in June is now located at Kenova, W. Va., with the Jeffery-Dewitt Insulator Co.

Gerald Fitz-Gerald, formerly of the Maxon Furnace & Engineering Co. can be found at 20 Hockley Hills, Gem Building, Birmingham, England.

Herbert Forester, of the Veritas Firing System, Cleveland, Ohio, has moved to a suburban home on Bassett Road, Bay Village, Ohio.

G. W. Greenwood, who is secretary and a director of the United Refractories Co.,

is also Resident Manager of Curwin's Accountancy Co., Inc. with headquarters at Wilkesbarre, Pa.

Mokiji Ichijo, a graduate of O. S. U., can now be addressed in care of Japanese Consulate General, 165 Broadway, New York City.

F. A. Kirkpatrick, has left the Jeffery-Dewitt Insulator Co. of Kenova, W. Va. and is at present on a vacation in Unionville, Mich.

P. William Lee, formerly located at 395-14th Ave., Columbus, Ohio, is now at 3401 Race St., Denver, Colo.

E. H. Lintz, of the Jewett Refrigerator Co., Lackawanna, N. Y., is now living at 404 Baynes St., Buffalo, N. Y.

Paul Niegsch, of the Porcelain Enamel & Mfg. Co., is living at 2437 Parkwood Ave., Baltimore, Md.

James G. Phillips, formerly of the U. S. Bureau of Mines, Columbus, Ohio, can now be found at 515 Cottage Ave., Piqua, Ohio.

W. C. Stief, has been changed from The Floretine Pottery, Cambridge, Ohio, to The Mt. Clemens Pottery Co., Mt. Clemens, Mich.

William C. Snowden, has moved from Sheffield to Stockton-on-Tees, England.

Wlbur Stout, with the Ohio Geological Survey, formerly addressed R. F. D. 1 is now located at 154 Erie Road, Columbus, Ohio.

W. F. Wenning, of 3313 Allendale St., has changed to 3447 Allendale St., Pittsburgh, Pa.

H. G. Willetts, of the Willetts Company, has asked that his mail be sent to P. O. Box 1047, Pittsburgh, Pa.

Northern Ohio Section of American Ceramic Society
Minutes of the Fifteenth Meeting

The 15th meeting of the Section was held Tuesday, June 6, 1922, in the rooms of the Cleveland Engineering Society, Hotel Winton, Cleveland, Ohio, with an attendance of ten members. Various matters pertaining to the welfare of the Section were discussed informally before and during lunch, which was served at 1:00 P.M. The only matter acted on officially was the appointment of a representative on the Society's Nominating Committee, the Secretary being unanimously chosen.

The afternoon was devoted to an inspection of the canal road plant of the Cleveland Builders Supply and Brick Company, the trip being made by automobile. This plant is very modern and produces high-grade face brick from local shale. There are eleven rectangular, down-draft kilns, each holding about 150,000 brick, and the daily production is 55,000. Each kiln is 17 x 90 feet in size, and has 22 fire boxes, coal being the fuel used.

Mr. E. E. Roll, who has general supervision of the kilns at all the plants of the company, explained new improvements which he has devised in firing methods, resulting in a marked decrease in coal consumption. The Section is greatly indebted to him for his kind interest, also to Mr. J. F. McKay, plant superintendent, whose delightful hospitality added much to the success of the meeting.

A. F. GORTON, *Secretary.*

Third Conference of the International Union of Pure and Applied Chemistry

The third conference of the International Union of Pure and Applied Chemistry was held at Lyons, France, June 27 to July 2 under the presidency of Dr. Charles

Moureu. Twenty-three countries were represented at the meetings. America was represented by the following delegation, C. L. Parsons, E. W. Washburn, H. S. Washington, R. B. Moore, Edward Bartow, and W. D. Bancroft, members of the Council, and Messrs. W. A. Noyes, A. C. Langmuir, John Frazer, Atherton Seidell, and A. P. Matthews, members of the General Assembly. Three meetings of the Council and two meetings of the General Assembly were held. The sessions were interspersed with committee meetings, social events, scientific lectures and numerous excursions to factories in Lyons and vicinity. The visiting delegates and their ladies were royally entertained by the people of Lyons and the meeting was in every way successful and will be long remembered by all present.

At the final session of the General Assembly, Sir William Pope was elected President for the ensuing three year term and it was voted to hold the next meeting of the Union in the Summer of 1923 at Cambridge, England. After the adjournment of the Conference, the delegates were the guests of the Lyons Committee on a steamboat excursion down the Rhone to Avignon whence the delegates proceeded to Marseilles where they were the guests of the French Society of Industrial Chemistry at its annual meeting and where they had the opportunity of visiting the French Colonial Exposition.

The following committee reports which were adopted at Lyons are of especial interest to members of the American Ceramic Society.

Report of the Committee on National and International Fuel and Ceramic Research Laboratories

The committee made the following recommendations:

1. Each country belonglng to the Union shall be invited to establish, through a committee or other suitable agency, a systematic nomenclature for fuels, and legal and commercial definitions of the various combustibles together with an exact description of their various properties, physical, chemical, physico-chemical and organoleptical.

2. Through the same agency each country shall also make a complete compilation of the methods and apparatus of research, analysis, and testing, which are employed in the country, either officially or commonly, to the end that this information may be available as a basis of discussion for formulating, ultimately, a set of standard definitions and methods which shall be internationally adopted.

3. In order to facilitate the exchange of information the Committee requests that the committee or other agency established in each country shall correspond directly with the President of the International Committee on Fuels.

Report of the Committee on an International Definition of the Term "CERAMIC"

The committee had before it an excellent French translation of the report of the American Ceramic Society's Committee on Definition of the Term "Ceramic." This report was printed and placed in the hands of all the delegates in attendance at Lyons. The committee approved unanimously the recommendations contained in this report and voted that it serve as the basis of discussion of the question which should be brought before the next meeting of the Union for final consideration, after each country belonging to the Union had had an opportunity to study the report and contribute to the discussion.

Report of the Committee on Chemical Periodicals

The following extracts from the Committee's report are of special interest:

1. All literature references should be given in terms of the abbreviations employed by Chemical Abstracts.

2. The official abbreviation of the word "Japanese" shall be "Japan."

3. All papers shall bear the address of the author or of the laboratory from which they originate.

4. All papers shall be accompanied by an abstract in one of the four languages English, French, German or Italian.

E. W. WASHBURN, *Delegate.*

Report of Research Committee, U. S. Potters Association

The Research Committee reported to the U. S. Potters Association on the progress of its work at the summer meeting held at the Stacy-Trent Hotel, Trenton, N. J., August 2nd.

The first report was made by Mr. Thomas B. Anderson on the use of forced draft burners, for the combustion of natural gas in bisque kilns. From the results obtained it seems that the use of low pressure air in this connection has proven successful from the standpoint of improved burning. More uniform firing is obtained and the heat can be driven to the center of the kiln without over-heating the first ring. Little if any gas is saved and the heat is harder on the kiln mouths and bottoms. There is also more radiation from the kiln walls. The uniformity of the ware and the satisfactory color obtained have justified the installation.

Mr. C. H. Walker reported upon the question of kiln dirt. He advised the use of mechanically stronger saggers, frequent lawning of the glaze, cleaning of the inside of the kiln crown, somewhat slower firing up and cooling, the use of non-flying clay in the wads and the elimination of the sliding of the saggers upon each other, as factors which tend to reduce losses due to kiln dirt. The results from a questionnaire indicated that the life of saggers is on the average from 10 to 13 firings.

Mr. S. B. Larkins reported that a mixture of pottery plaster and white Portland cement, in the proportion of 2 to 1 yields good pottery cases. He also described a satisfactory kiln damper.

Mr. John S. George submitted the results of a questionnaire on lawns and found that about an equal number of rotating and reciprocating lawns are used and that the average capacity of all lawns is approximately 285 pounds per hour, and per square foot. The potteries that use wire cloth employ the 110 or 120 mesh and those using silk lawn the meshes known as IIXX and 12XX.

Mr. F. K. Pence submitted a table in which tests are compiled for the differentiation of the various pottery materials.

Mr. Ira E. Sproat reported upon the properties of three promising clays for the pottery industry, a semi-ball clay from Missouri, a prepared clay from North Carolina and a kaolin-like clay from Tennessee, of considerable apparent value.

He also submitted the results obtained with the use of cobalt sulphate, precipitated with carbonate of soda, as a body stain. He found that a solution composed of 200 ounces of water, 5.5 oz. of cobalt sulphate and 3 oz. of carbonate of soda added to 3000 pounds of body gave the same tint as the regular stain. It was stated, however, that where 60 or more per cent of the water is used over again trouble will occur owing to the concentration of the sodium sulphate which interferes with the casting. It is advised to use only a portion of the water over again or to make up a separate casting body.

Mr. A. V. Bleininger discussed the importance of allowing for the water content of the different body materials and raised the question as to what should be considered a normal water content for each material since it is evident that none of the compositions usually given are based on the use of dry weights. He submitted results obtained at different plants.

The same speaker described also good casting practice and advocated the use of as heavy a slip as possible, with a gravity of 1.8 for the pipe system and 1.78 where

barrels are used. The proportion of soda ash to liquid silicate should be kept in the ratio of 1:2 and under no circumstances should the fluidity of a slip be increased by the addition of water, but only by the systematic addition of the alkaline materials.

The reports of Messrs. Larkins, George, Pence and Sproat were read by the chairman. The latter then submitted to the Association the plan of the AMERICAN CERAMIC SOCIETY to conduct a comprehensive research on saggers as outlined by Mr. Treischel at the St. Louis meeting of the Society. After some discussion the Research Committee was instructed to prepare a reply to the Secretary of the Ceramic Society and to recommend a course of action.

The chairman next discussed the tests of pottery adopted tentatively in conference with the Bureau of Standards and the additional work now being done on this subject in Washington. It was pointed out that such tests are not only of importance in classifying pottery but can be made to serve in plant practice in assisting to maintain constant quality and to test out the glaze fit.

The chairman emphasized the need of determining accurately all the physical properties of American pottery and the materials used, such as the heat expansion of body and glaze, the effect of glaze fit upon the mechancial strength, the resistance of the glazes to abrasion, etc., and it was suggested that the Association enter upon an investigational program along these lines in coöperation with the Bureau of Standards. The Association then voted an amount not exceeding $3000 for the inauguration of such a research at the above Bureau.

A. V. BLEININGER, *Chairman.*

We Thank You

"If we satisfy, you tell it to others; if we do not, please whisper it to us," is a well known pert advertising phrase.

We get many a whispered and sometimes a shouted criticism of what we have done that we ought not to have done, or have left undone that we ought to have done. A paragraph like the following, therefore, comes like a double mint ice cream soda with two straws, on an August day in central Ohio.

> "Enclosed you will find personal check payable to the Society for membership dues for the year 1922.
>
> Your kind letter July 31st received and I wish to thank you personally for sending me the June number of the *Journal*. I received many times the value of the membership in this one issue alone. I certainly wish that the back numbers and the coming issues be forwarded to my office address.
>
> Wishing you personally and the Society in general unlimited success and trusting you will have an enjoyable outing with your fellow workers this summer. It will be a glorious trip and one that I would certainly enjoy if it would be my good fortune to go."

Such a message refreshes us, makes us feel good all over, and enables us to go back to work with zest.

A Step toward Coöperation

Mr. Ross C. Purdy, General Secretary,
American Ceramic Society,
Columbus, Ohio.

My dear Sir:

I have delayed answering your letter of June 30 until I could get time to read over the pamphlets that accompanied your letter.

I am extremely interested in the subject matter of your letter and of the pamphlets, and particularly that which relates to coöperation of your Society with state geological surveys.

The North Carolina Geological and Economic Survey, through its geological and mining division, is taking up particularly investigations relating to clay, feldspar and quartz deposits of North Carolina. In connection with these investigations we have immediately realized the need of a ceramic laboratory. At the present time there is not, as far as I know, a fully equipped ceramic laboratory in the South; and as Director of the North Carolina Geological and Economic Survey, I am very anxious to arrange to have established here at the University of North Carolina, with which the Survey is associated, an up-to-date and complete ceramic laboratory which will enable us to thoroughly test our clays and feldspars; be able to test out all types of mixtures for pottery, tile, terra cotta, firebrick, and common brick, etc. There are many problems in connection with the clays of this State that need to be worked out, and I want to be in a position to work them out within the State. A ceramic testing laboratory, if erected at the University of North Carolina, could and probably would be used by nearly all the Southern States.

Dr. Ries of Cornell University has done considerable work for this Survey on the clays of North Carolina; as has also Mr. Watts of Columbus. We hope to have associated with us within the next year, a geologist who is thoroughly acquainted with clays and clay products. We are also associating with us men who are thoroughly familiar with the technical side of the ceramic industry.

I can assure you that we shall be very glad to coöperate with your Society in every way possible.

Would this Survey be eligible for membership in the Society; and if so would it be under the head of Corporation Members?

Yours very truly,

(Signed) JOSEPH HYDE PRATT, *Director*

SUMMER MEETING
THE CANADIAN TOUR

An Account of the Summer Excursion Meeting Aug. 13–20, 1922

BY ALEXANDER SILVERMAN

The writer has been requested to prepare an account of the Summer Convention, just ended. If he becomes sentimental, or follows the flights of his fancy at times, it is only because he has had the fortunate privilege of being a party to what may unhesitatingly be termed the "most wonderful" tour ever afforded a group of technical men. "Perfection" is the only qualification which will properly fit the "Canadian Tour." Not a drop of rain marred the excursion. It was attractive technically, educationally, historically, scenically and gastronomically. About sixty members and their guests constituted the party.

Through arrangements made by Dr. E. W. Tillotson, the Eastern Ohio, West Virginia and Western Pennsylvania contingent boarded a special car in Pittsburgh on the Buffalo, Rochester and Pittsburgh Railroad at 10 o'clock Sunday morning, August 13th, in charge of Mr. Herrick, Asst. Passenger Agent of the road. Within an hour all were acquainted with each other. A word should be said here of the welding influence of our good friends, Mr. and Mrs. J. G. Kirk of New Castle, Pa. Arrangements were made by the railroad for taxicab and bus service at Rochester, where the group was conveyed to the steamer landing.

At this point members of the Society from other districts joined the party, which boarded the steamer "Kingston." Here was the first evidence of the perfection and detail with which the tour had been planned by our worthy Secretary, Dr. Ross C. Purdy. Transportation had been provided and rooms were available at once on a boat which was crowded beyond its cabin capacity. Sunrise found us in the much-heralded Thousand Islands, and at 10 o'clock we transferred at Prescott, Ontario, to the "Rapids Prince," which conveyed us through Long Sault, Coteau, Cedar, Split Rock, Cascade and Lachine Rapids, with their accompanying scenic beauty, to Montreal, from whose harbor we obtained a most impressive view of Mt. Royal.

Mr. G. Percy Cole of the Dominion Glass Company, local chairman, had buses at the station, and we were taken to the Windsor Hotel, where it was not even necessary to sign the register; our rooms were ready for us, as they were at all hotels subsequently visited. After dinner, an informal meeting was held, at which plans were formulated for Tuesday's schedule. Messrs. Cole, Johns and others addressed the gathering. Light refreshments and an informal smoker followed.

On Tuesday morning, we were the guests of the Harbor Commissioner on his private launch. After viewing the harbor, which, according to information furnished, is the only one in the world yielding a profit, we visited the enormous municipal warehouse and cold storage plant, which has just been completed. That this plant is conducted on scientific principles, was clear from the humidifying apparatus and ozonizing machinery installed to prevent evaporation, and ensure preservation of food stored in the building. Interesting evidence was furnished us also of the care exercised in the planning of the building, whose floors and walls are built of concrete having a heavy cork interlining for heat insulation. During the afternoon, the party was divided into groups, one of which visited the Consumers' Glass Company, operating semi-automatic bottle machines; and another the Gurney Foundry Company, manufacturing enamelled stoves and signs. A third group motored through the city and environs, visiting McGill University and other points of interest. Evening found us at the banquet table, where we were privileged to hear a most interesting address by the President of the King's Council. He emphasized the need for a correct history of the early relations between Canada, the mother country and the United States, so as to ever ensure friendly relations between our Canadian neighbors and ourselves. Other speakers were President Riddle and Mr. Chapman of the Chapman Engineering Company. Prominent officials of the Province of Quebec were introduced. A formality which characterized this, as well as all subsequent banquets, was the drinking of a toast to the King and to the President of the United States, followed by the singing of the respective national anthems. An interesting feature of the musical program was the rendition of a French Canadian song, "Alouette," whose tuneful melody at once appealed to our party; in fact, was our group song during the remainder of the trip.

Wednesday morning found us aboard two special parlor cars, provided by the Canadian Pacific Railroad, and in charge of Majors Burke and Omannay, representatives of the C. P. R. Mention should be made at once of the solicitude and care given us by these gentlemen, who accompanied the party as far as Kingston. They provided every facility possible, in fact were such an integral part of our group that we were loath to part with them. At 10.20 A. M., we arrived in Buckingham, where ex-Mayor "Bob" Cameron and Mr. N. B. Davis, superintendent of the Derry feldspar mine owned by O'Brien and Fowler, met us with a sufficient number of automobiles to motor the entire party some ten miles into the mountains. The product of the Derry mine is a snow-white feldspar of unusual purity and freedom from foreign minerals. After viewing the mining operations, we were guests at a camp dinner, where a French Canadian quartet composed of prominent business men of Buckingham, entertained us with more

of those delightful French songs. Following the dinner, addresses were made by Dr. McLish, Minister of Mines of the Province of Ontario; Mr. Davis, superintendent of the plant; Messrs. Frechette, Omannay, Riddle, Purdy and Silverman. A further inspection of the mine followed the luncheon, and then the party motored back to Buckingham to the special cars.

Six o'clock found us in Ottawa, the garden city of all Canada. Her magnificent buildings, with their Gothic spires, her canals and waterways, her exquisite natural beauty, can never be forgotten. Messrs. Davis, Frechette, Merkley, and Dr. Keele of the Ottawa Department of Mines, constituted the local committee in charge. Our domicile was the famous Chateau Laurier, than which no hostelry ever had more beautiful surroundings. As soon as rooms had been assigned, the party motored to "Ye Olde Homestead Inn" in Val Tetereau, Quebec, across the Ontario dry line. Dining and dancing were the program of the evening. Later some of our party visited the ceramic laboratory of the Department of Mines and the Victoria National Museum of Ottawa.

Thursday morning included excursions to the famous Eddy paper mills, which manufacture all types of paper and pressed paper products; and the Merkley brick plant, making shale brick and fire-proofing materials. Other members of the party motored about the city and suburbs, viewing the magnificent Parliament buildings, Agricultural Gardens, and additional points of interest.

At 11.40 A. M., we were again on the C. P. R., reaching Verona at 2.30, thence motoring to the Richardson feldspar mine, located in the hills overlooking Thirteen Island Lake. Here Mr. R. F. Segsworth, an attorney from Toronto, interested in the mines, and a real host, together with President Taylor of Queen's University, Messrs. Townsend, Gardner, and members of the Kingston Council, led our inspection of the mine, which produces a high-grade pink feldspar, beautiful white quartzite and other minerals, which were especially interesting to the collectors in the group. Sufficient time was available for some of the party to take a plunge into the crystal clear waters of the lake. Again a motor trip, and at 6.30 westward bound on the C. P. R. to Kingston, the "West Point" of Canada and the seat of Queens' University. Here at 9 P. M., we were the guests of the Kingston Council at a banquet which lasted into the "wee sma' " hours of the morning. The speakers of this occasion were Sir Archibald Howald, Head of the Royal Military Academy; Dr. Taylor; and Msssrs. Keele, Hostetter and Beecher. After the speeches, Messrs. Burke and Omannay of the C. P. R., who had to leave us at this point, were given an ovation. Following the banquet, we were conducted to the town hall to view illuminated memorial windows depicting the principal battles of the late war. Needless to say, we literally dropped into our berths in the special sleepers which carried us to Toronto.

The party arrived in Toronto at 7.30 Friday morning, going immediately to the King Edward Hotel. Toronto's local chairman was Mr. M. F. Gibson, a former pupil of Secretary Purdy, who furnished us with a mimeographed schedule, which indicated another busy day. At 10.30, we were the Harbor Commissioner's guests on several launches, which carried us through the gigantic harbor of the city and out to Toronto's various lake resorts. Our party lunched together at the King Edward, and in the afternoon split into groups, one of which visited the Standard Sanitary Manufacturing Company's plant; another that of the Jefferson Glass Company, where lighting ware is made; and a third motored through the city and visited the Queen's Museum, the University of Toronto, the Parliament buildings and the Exposition grounds. At dinner we were the guests of Mr. and Mrs. Abel Hansen, of Perth Amboy, New Jersey. These genial hosts had already won the love of every member of the party. The speakers were Brigadier General Mitchell, Dean of the Department of Applied Science of the

University of Toronto; and Messrs. Gibson and Riddle. Dean Mitchell outlined plans for a department of ceramic engineering at the University of Toronto, whose development will result in valuable coöperation with the ceramic, glass and mineral industries of Canada. After the dinner, part of the group visited "Sunnyside" (Toronto's Coney Island), and others gathered in the home of Mr. Segsworth, where they viewed the rare collection of paintings, etchings and engravings which he has collected with painstaking care. His art treasures also include precious ceramic and glass specimens.

On Saturday at 8.15 A. M., we left Toronto by boat for Hamilton, arriving at 11. Here Mr. H. F. Dingledine took charge of the party. After a visit to the Canadian Porcelain Company's plant, manufacturing electrical porcelain, and to the Libbey-Owens Sheet Glass plant, lunch was served at the Royal Connaught Hotel. Four o'clock brought sad farewells, and the party scattered, some bound for Canadian lake resorts, others visiting Niagara Falls, en route to their homes.

The Canadian tour furnished evidence of the splendid mineral resources of Canada, of her manufacturing enterprise, and of her real men and women who were our hosts on all occasions. Let me repeat what I have already said of Secretary Purdy. His wonderful eye for detail and anticipation of the comfort of every member of the party made the trip perfect, and never to be forgotten. This article may well be concluded by a psalm dedicated to Canada by one of our party.

"Canada is our hostess: we shall not want.

She motoreth us through green pastures, and leadeth us by rapid waters.

She restoreth our soul.

She guideth us into paths of interest, for our mind's sake.

Though we trail and shoot rapids of death, we fear no evil; her guides are ever with us.

Her grain and her vine, they comfort us.

She prepareth a table before us in the presence of our friends.

She maketh our hearts rejoice.

Surely her goodness and kindness will follow us all the days of our life; and she shall dwell in our thoughts forever."

NOTES AND NEWS

Past President Cullen W. Parmelee Designated as Acting Head of Department of Ceramic Engineering University of Illinois

BIOGRAPHICAL DATA

Born, Brooklyn, New York in 1874.

Graduated from Rutgers College 1896 with degree of B. Sc., and honors in Chemistry. Also, elected to Phi Beta Kappa in senior year for scholarship.

Editor-in-chief of the College Weekly.

Spent five years as chemist with the New York and Boston Dyewood Co., Brooklyn, New York, manufacturing natural dyeing and tanning extracts.

Returned to Rutgers College as instructor in Chemistry in 1901. Organized the Department of Clay Working and Ceramics in 1903 and was Director until 1916. Served as Associate Professor of Applied Chemistry from 1905–08. Professor of Ceramics 1908–16.

Appointed Professor of Ceramic Engineering at the University of Illinois, 1916. Acting Head 1918–1919. Designated Acting Head of the Department for 1922–23.

Served as Trustee, Vice-president and in 1914–15 was President of the American Ceramic Society. Chairman of the Committee appointed to consider the publication by the Society of a journal which resulted in the Society undertaking that enterprise.

Organized the New Jersey Clay Manufacturer's Association in 1914 and was Secretary 1914–1916.

Secretary of Illinois Clay Manufacturer's Association 1917–

Appointed District Chief for Illinois Industrial Furnace Section, U. S. Fuel Administration, 1918.

Member of the Joint American Foundrymen's Association and Division of Engineering, National Research Council Committee on Molding Sand Research.

Consulting Ceramist for Illinois Geological Survey, 1917–

Chairman Committee on Data, American Ceramic Society, 1922–

Member of American Society for Testing Materials, English Ceramic Society, American Chemical Society, Beta Theta Pi, Sigma Xi.

C. W. Parmelee

Author of numerous papers presented before the American Ceramic Society, also co-author of Report on the Peat Deposits of Northern New Jersey, published by the New Jersey Geological Survey, 1905; and co-author of Further Investigations of Illinois Fire Clays, Illinois Geological Survey, 1921.

Coöperative Research Work of Clay Products Associations

The Eastern and Western Clay Products Associations are joining their support of coöperative research work with the Mellon Institute of Pittsburgh. The purpose of this research work in general is to improve the quality of sewer pipe and to reduce the cost of manufacture. Their aim is to manufacture more uniform and stronger sewer pipe; one also that will better resist the action of sewage chemicals.

Clay sewer pipes have withstood the requirements of modern times in a satisfactory fashion, but it is that the sewer pipe manufacturers may be forearmed to meet the ever-increasing demands and ever increasing severity in requirements that they desire to improve their product, and at the same time manufacture it at lower cost.

Mr. Harry G. Schurecht, a long standing member of this Society, well known because of his researches and writings, is employed by these associations as their Fellow. A very brief sketch of his training is as follows:

Received B.S. in Ceramics at University of Illinois, June, 1914.

Ceramist for The Findlay Clay Pot Company, Washington, Pa. July 1, 1914 to September 1, 1915.

Laboratory Assistant in Ceramics at The U. S. Bureau of Standards, Pittsburgh, Pa., September 1, 1915 to April 1, 1916.

Ceramic Chemist, U. S. Bureau of Mines, Columbus, Ohio, April 1, 1916–April 1, 1922.

Fellow for the Eastern Clay Products Association, and The Clay Products Association, The Mellon Institute, Pittsburgh, Pa., April 1, 1922.

H. G. Schurecht

H. T. Shelley

He has just started upon the latter work, hence we can not at this time make statement as to what problems these associations will be engaged upon first.

G. F. Lenth

We herewith have the pleasure of showing the likeness of Mr. H. G. Schurecht, and also that of Messrs. H. T. Shelley and George T. Lenth.

Mr. H. G. Shelley is managing secretary of the Eastern Clay Products Association, municipal engineer of wide experience and reputation, an organizer, and one with appreciation of the need and benefit of plant control in improving quality and reducing cost of manufacturing of sewer pipe.

Mr. Lenth is Secretary of the Western Clay Products Association. He has had many years' experience as City Engineer, is widely known, and his counsel is sought wherever there are questions regarding the use of sewer pipe.

The American Ceramic Society is always pleased to see such coöperative contacts made, for thus, and only thus will the sum of our knowledge be increased. It brings contact of the collegiate institute with the industry, and the industry with the institute,—a happy and profitable combination.

Tests for Fire Brick

At the last conference, at the Bureau of Standards, with the Advisory Committee on Specifications for Refractories, which is made up of representatives of producing and consuming industries and interested technical societies, somewhat wide differences of opinion were expressed as to the proper test requirements for fire brick for the linings of stoker-fired boilers and it became apparent that a systematic investigation would have to be made before various essential points could be satisfactorily settled. As a result, Mr. Howe has made additional tests of something like forty different brands of fire brick at Mellon Institute, and an extended coöperative investigation has been undertaken at the Bureau of Standards.

At the request of Mr. E. B. Powell, Consulting Engineer of Stone and Webster, approximately forty large power house operators have sent to the Bureau for test, samples of the brands that they are using. By means of questionnaires sent to these power companies, Mr. Powell is collecting as complete information as possible on the service given by all the brands of brick represented. The correlated information will later be compared with the data from the tests. Practically all of the established tests for refractories and some additional tests are to be applied to all the brands received.

Several months will be required to do the work but it is believed that when this investigation is completed the information available from all sources will be sufficient to make it possible to arrive at definite and satisfactory conclusions as to what test requirements should be included in specifications for fire brick for stoker-fired boilers. As the brands of brick included in these tests are used in other types of service as well, the test data can be used in the preparation of specifications for refractories for other specific uses.

Oxidation of Ceramic Wares during Firing

From U. S. Bureau of Mines

In the study of the oxidation of ceramic wares during firing, being conducted at the Columbus, Ohio, Experiment Station of the Bureau of Mines, substantial progress is being made in the investigation of the rate of evolution of sulphur dioxide and trioxide at different temperatures and atmospheres. This work has reached a point where it was deemed advisable to check laboratory work with industrial practice. Samples of flue gases at all stages of the burn were recently collected at the plant of the Fallston Fire Clay Company, Fallston, Pa. Observations of the so-called "blue smoke" were made at this plant.

Calendar of Conventions

With the summer meeting now off of our Calendar of Conventions and already a matter of history, the most important event to plan for is the Annual Meeting in February, 1923. This meeting, which will mark the quarter century of the activities of the American Ceramic Society, is already progressing toward the completion of arrangements.—Notice that in this list this announcement stands out in large type—"There's a reason."

American Chemical Society—Pittsburgh, Pa., September 5–9, 1922.

National Association of Brass Manufacturers—Detroit, Mich., September 6–8, 1922.

Association of Iron and Steel Electrical Engineers—Cleveland, Ohio, September 11–15, 1922.

Eighth National Exposition of Chemical Industries—New York City, September 11–16, 1922.

American Electrochemical Society—Montreal, Canada, September 21–23, 1922.

American Institute of Mining and Metallurgical Engineers—San Francisco, Cal., September 25–28, 1922.

National Association of Commercial Organization Secretaries—Chicago, Ill., October 23–25, 1922.

National Society for Vocational Education—Detroit, Mich., November 30–December 2, 1922.

Dental Manufacturers Club—St. Louis, Mo., November 20, 1922.

Dental Exhibit of the Dental Manufacturers Club—St. Louis, Mo., November 21–24, 1922.

National Exposition of Power and Mechanical Engineering—New York City, December 7–13, 1922.

Mining and Metallurgical Society of America—New York City, December 7–13, 1922.

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National Jewelers Board of Trade—New York City, January 18, 1923.

Canadian National Clay Products Association and Western Ontario Clay Workers Association—Hamilton, Ont., January 24–26, 1923.

American Concrete Institute—Detroit, Mich., February, 1923.

National Association Builders Board of Control—Des Moines, Iowa., February, 1923.

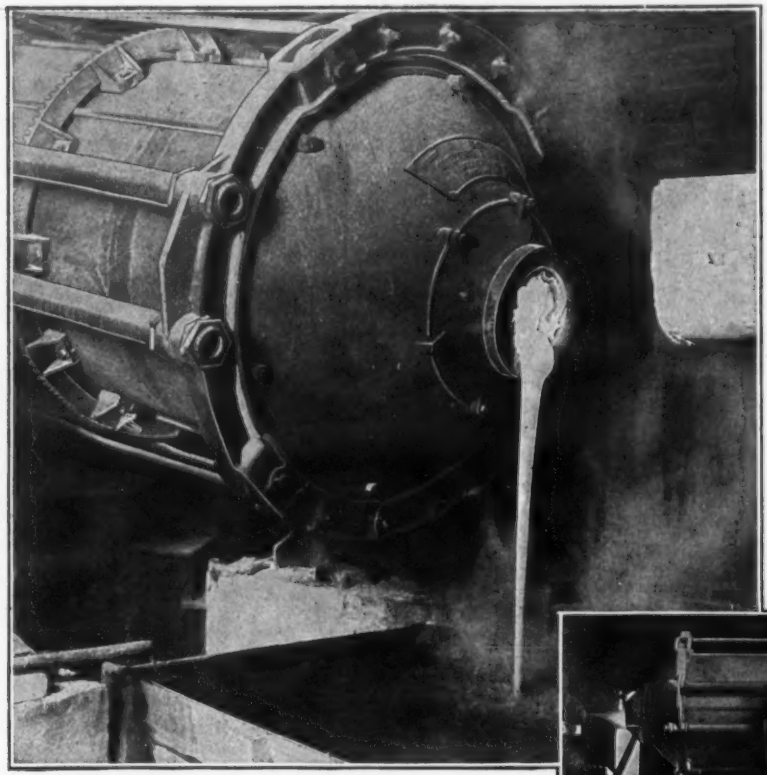
AMERICAN CERAMIC SOCIETY—Pittsburgh, Penna., February 12–17, 1923.

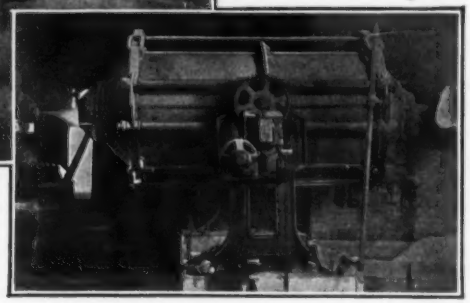
National Gas Association of America—Louisville, Ky., Spring, 1923.

American Institute of Mining and Metallurgical Engineers—New York City, February 19–22, 1923.

National Association of Stove Manufacturers—Richmond, Va., May 9–10, 1923.

American Association of Museums—Charleston, S. C., May, 1923.





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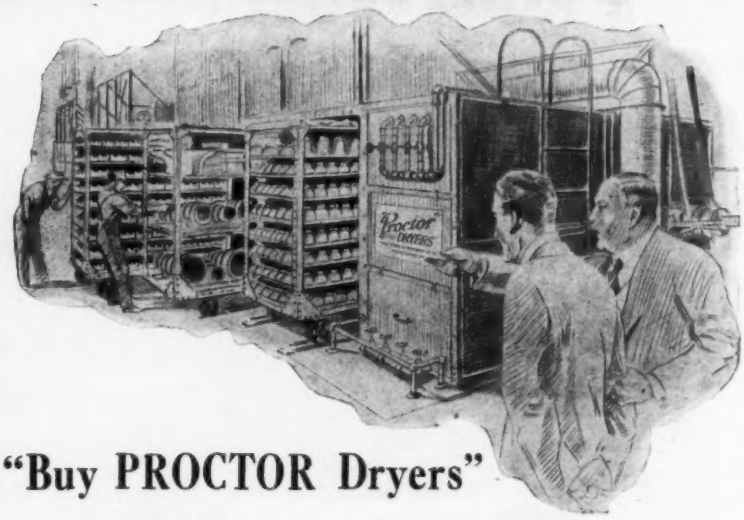

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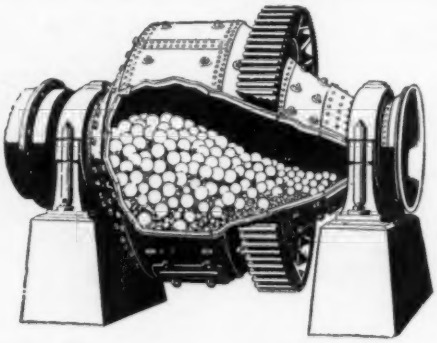

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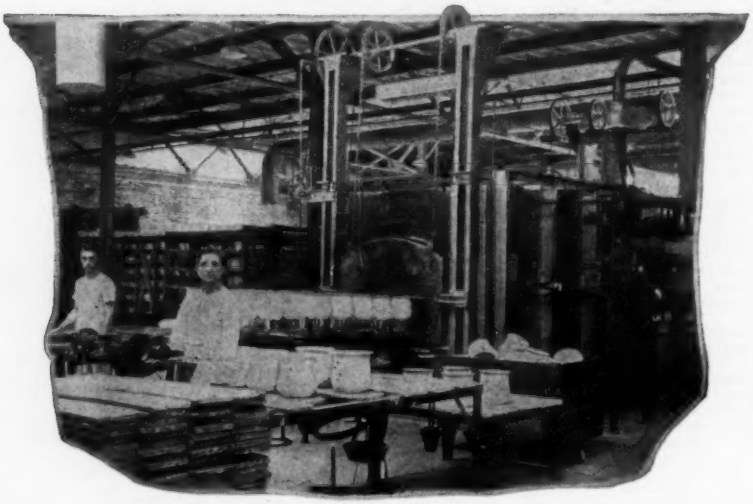

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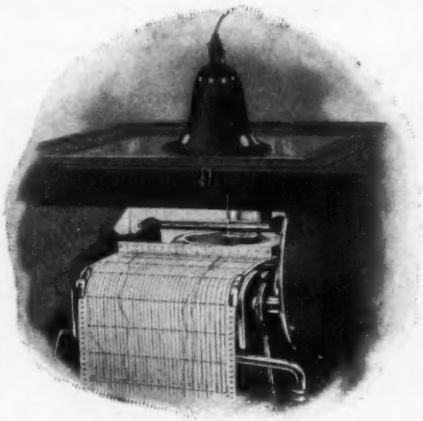

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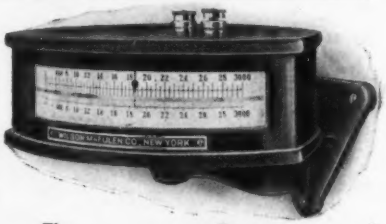

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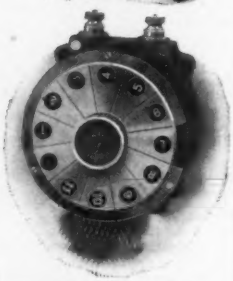

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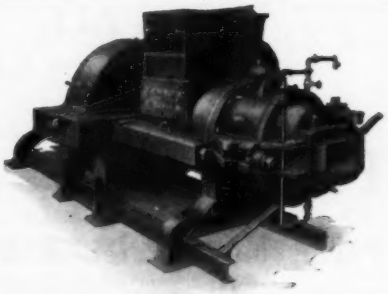

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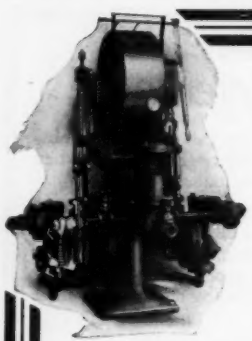

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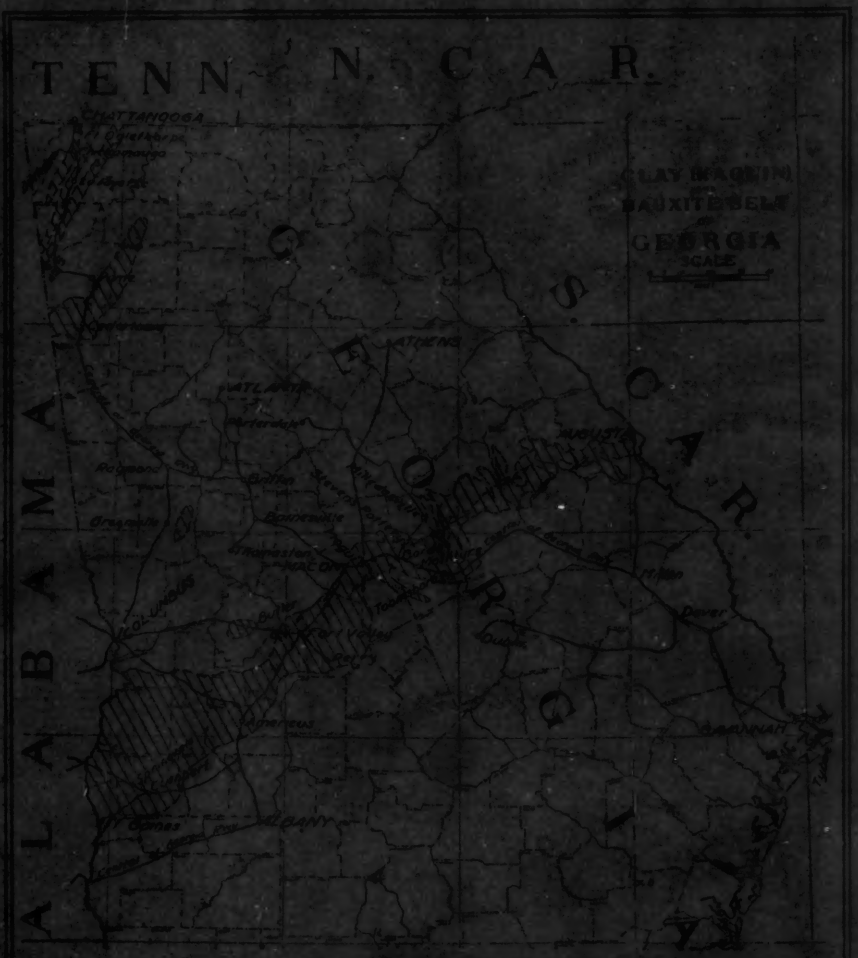

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